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K. V. BYRE GOWDA
S. V. HARIDAS
Secretaries

Dated 25th February, 1958

The
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AN INQUIRY INTO THE ECONOMIC EFFECTS OF BUNDING IN NORTH MYSORE[1]

Introduction

An inquiry into the economic benefits of bunding was held in the year 1955–56 in the Karnatak region of the former Bombay State, comprising the four Kannada-speaking districts, *viz.*, Belgaum, Dharwar, Bijapur and North Kanara. As a result of the reorganisation of States, these districts have now been included in the Mysore State, and form the northern part of the New Mysore State. The four districts have a population of 51,35,746[2] and an area of 21,400·6 sq. miles. Agriculturally the area can be divided into four units, *viz.*, (1) The Western Coastal Belt, (2) The *Maland* Region, (3) The Transitional zone and (4) the Dry Tract. The main features of each unit are as under:—

The Western Coastal Belt

The belt receives a heavy rainfall ranging from 90–150″. It has a warm humid climate. It is covered by thick forests. Paddy is the main crop of the region.

The Malnad *Region*

It covers parts of the North Kanara, Dharwar and Belgaum Districts. It has an assured rainfall varying from 30–90″. A variety of crops ranging from rice to ragi are grown in this region, sugarcane being the important money crop.

The Transitional Zone

The transitional zone comprising parts of the Dharwar and Belgaum Districts receives an assured annual rainfall of about 30″. *Jowar* is the main cereal crop, but a variety of crops such as wheat, groundnut, gram, chillies, tobacco and cotton are also raised.

The Dry Tract

This tract covers almost the whole of Bijapur District and the eastern parts of Dharwar and Belgaum Districts. A trying, hot climate, scanty and uncertain rainfall, and consequent scarcity and famines are the peculiar features of the region. Rainfall varies between 15″ and 25″

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[1] Conducted by the Agricultural Economics Section, College of Agriculture, Dharwar, and communicated by Sri. N. P. Patil, Professor of Agricultural Economics.

[2] Figures from the 1951 Census. Chandgad Taluka of Belgaum District has been excluded, being now assigned to the Bombay State.

and is often very unevenly distributed. The region is completely dependent on agriculture, with *jowar* (*Sorghum vulgare*) as the main food crop and cotton as the chief money crop.

Bunding is mainly concentrated in the dry tract where the rainfall is scanty and uncertain, and has for its main objects conservation of soil-moisture, and prevention of soil erosion.

Origin of the Scheme

Various advantages, such as increase in crop yields, increase in subsoil water-level, increase in the area under cultivation, were attributed by the Department of Agriculture, to bunding. But these claims were not substantiated by statistics. The Director of Agriculture, Bombay State, during the course of his inspection of bunding works, expressed the desire that the advantages claimed should be substantiated by undertaking a brief and rapid survey of the areas where bunding had been undertaken in the State. The matter was further discussed in the "Agresco" (Agricultural Research Conference) on the 8th May 1953, and the Committee decided to undertake this work.

Design and Conduct of the Scheme

As decided in the Agresco Meeting the work was entrusted to the Professors of Agricultural Economics, at the Poona and Dharwar Agricultural Colleges. A scheme to inquire into the economic effects of bunding in the Bombay State was formulated by the Professors in consultation with the Statistician, Department of Agriculture. Simple questionnaires in forms A and B (not printed here) were prepared for collecting the data. The Professor of Agricultural Economics, College of Agriculture, Dharwar, was in charge of the scheme as far as the collection of data and its compilation were concerned in the Karnatak region. The Professor of Agricultural Economics of the Agricultural College at Poona was in charge of the scheme in the other areas. The Statistician designed the plan of investigation. In all, 78 villages and 745 cultivators were selected in the whole State, by the random sample method. Of these, 32 villages and 297 cultivators were from the Karnatak region.

The two forms of questionnaires were printed and supplied to the Divisional Soil Conservation Officer, as the inquiry was to be conducted through him. Before the forms were distributed to the cultivators the Professor of Agricultural Economics, Dharwar, explained to the field staff of the Soil Conservation Section, the object of the investigation, and trained them in the method of collecting the information from the cultivators at a meeting convened by the Divisional Soil Conservation Officer, Bijapur, for the purpose.

This report mainly deals with the data collected in the Karnatak Region which has now become part of the Mysore State.

The object of the inquiry is mainly to find out the extent to which the cultivators have benefited by way of increase in crop yields, increase in the subsoil water-level, increase in the area under cultivation, and also to find out if bunding had enabled them to adopt improved methods of agriculture, and if it had promoted subsidiary occupations.

TABLE I

Yield of crops before and after bunding

Name of crops	No. of cultivators supplying the information	Tot l yield per acre		Average yield per acre per cultivator		Increase in yield after bunding	% increase
		Before bunding. B.Ms.Srs	After bunding Ms. Srs.	Before bunding Ms. Srs.	After bunding Ms. Srs.	Ms. Srs.[7]	
Kharif Jowar[3] ..	192	554—1	646—35	2—33	3—14	0—21	18·5
Rabi Jowar[4] ..	24	71—19	89—30	2—39	3—29	0—30	25·2
Bajri[5] ..	193	312—31	378—08	1—24	1—38	0—14	21·8
Navane[6] ..	5	6—15	7—20	1—11	1—20	0—09	17·6
Wheat ..	36	95—25	103—30	2—26	2—35	0—03	8·5
Pulses ..	156	204—18	248—37	1—12	1—23	0—11	21·1
Groundnut ..	141	396—34	496—24	2—32	3—20	0—28	25·0
Cotton ..	62	172—36	194—24	2—31	3—05	0—14	12·6
Average ..	..	..	..	..	..	..	18·68

[3] Sown in July. [4] Sown in October. [5] *Pennisetum typhoides*, Pearl Millet ಸಜ್ಜೆ. [6] *Setaria italica*, Italian Millet.

[7] *Weight in Bombay Maunds and seers.*

The figures show that there is an increase in the yield of crops after bunding. The increase varies from 25·2% in the case of *rabi jowar*, to 8·5% in the case of wheat, the average increase in yield being 18·68%. In this connection 217 cultivators out of 275 (*i.e.*, 76·9%) have expressed the opinion that the bunding work has resulted in the increase of yield.

The figures show an increase in the area under cultivation after bunding by 3·43%.

Table II

Table showing area under cultivation before and after bunding

	Acres	Guntas*
Total area bunded of 292 cultivators ..	3030	26
Area under cultivation before bunding ..	2915	34
Area under cultivation after bunding ..	3016	3
Additional area brought under cultivation after bunding ..	100	9
Percentage of additional area brought under cultivation after bunding	3·43	..

* 40 Guntas = 1 acre.

(*N.B.*—Out of 297 cultivators selected for inquiry only 292 cultivators have replied.)

Table III

Table showing the level of water in wells during October–November and April–May, before and after bunding

	October-November		April-May	
	Before bunding	After bunding	Before bunding	After bunding
*Level of water in well before bunding and after bunding (Total of 30 wells)	911′—0″	707′—0″	1091′—0″	917′—0″
Average level of 30 wells	30′—4″	23′—7″	36′—4″	30′—7″
Increase in water-level	6′—9″		5′—9″	
Percentage increase	28·6		18·8	

* Average distance between the ground level and level of water in the well.

The figures reveal that there is a rise in the level of water in the wells in the bunded area. The rise in water-level in the months of October–November is to the extent of 6′ 9″, and in the months of April–May to the extent of 5′ 9″, which, expressed in terms of percentage, comes to 28·6% and 18·8% respectively. This is a clear indication of the rise in the level of subsoil water.

Advanced Cultivation Practices

With regard to advanced cultivation practices in the bunded areas the inquiry reveals that in 22 out of 32 villages cultivators have been able to follow improved methods of agriculture, such as contour cultivation, wider spacing, thinner sowing and the use of improved seeds. But the extent of area under improved cultivation could not be ascertained.

Development of Subsidiary Occupations

An effort was also made to find out whether bunding has helped in developing subsidiary occupations. The inquiry revealed that only in 4 out of 32 villages subsidiary occupations like dairying and poultry farming have been taken up by the farmers which shows that bunding has no substantial effect on the development of subsidiary occupations.

Table IV

Table showing the area under cultivation and the area bunded in each district (in acres)

Districts	Total cultivated area	Area bunded			% of the area bunded
		Before 1946	Newly bunded	Total area bunded	
Bijapur ..	36,38,900	42,383	86,134	1,28,517	3·5
Dharwar ..	27,31,700	4,297	7,211	11,508	0·42
Belgaum ..	24 16,100	19,562	31,520	51,082	2·1
Karwar ..	2,67,500	..	..	..	..

The figures show that bunding is concentrated in the Bijapur, Dharwar and North Kanara Districts. The extent of area bunded shows vast scope for extending bunding activities in the region.

Table V

Table showing the area bunded in different types of Soils in the blocks selected for inquiry

S. No.	Type of soil	Area bunded	% to the total area bunded
		A. Gts.	
1	Light ..	3102—32	43·16
2	Medium ..	3228—31	44·92
3*	Deep black ..	857—2	11·92
	Total area bunded ..	7188—25	100·00

* Bunding in deep black soils has been discontinued and is now restricted to medium and light soils.

It can be seen from the table that bunding is undertaken mainly in the light and medium types of soils. The area bunded in the two types of soils is 6,331 acres 23 guntas, which is 88·08% of the total area bunded.

TABLE VI

Table showing the distance between two bunds and percentage of slope of land in bunded areas

(Average of 32 bocks)

S. No.	Particulars	Max.	Min.	Average
1	Distance between two bunds ..	342′	180′	266′
2	Percentage slope ..	2·33	1·08	1·59

The figures show that the average distance between two bunds is 266′ and the average percentage slope is 1·59.

CONCLUSIONS

As a result of the survey the following conclusions can be drawn:—

1. The yield of crops has increased by 18·68%.
2. There is a rise in the level of water to the extent of 28·6% in October–November and 18·8% in April–May.
3. There is an increase in the area under cultivation by 3·43%.
4. There are only a few instances where bunding has encouraged the development of subsidiary occupations such as dairying and poultry farming.
5. Farmers in the bunded area have been able to follow some of the advanced methods of agriculture advocated by the Department of Agriculture.
6. Bunding is undertaken mostly on light and medium types of soils. The average distance between two bunds is 266′ and the average percentage slope is 1·59.

The scheme is continued for a further period of 3 years.

ECONOMIC IMPLICATIONS AND PRACTICAL UTILITY OF THE INVESTIGATIONS

As there is vast scope for the extension of bunding activities in the Mysore State, the results of the inquiry are useful in many ways, which can be stated as under:—

1. They are useful to the Department in knowing exactly the benefits of bunding and extending the bunding work in the State.
2. They are also helpful to Government in convincing the cultivators of the usefulness of bunding by facts and figures.
3. The yield figures showing an increase in yield are useful to Government both in the valuation of land, and the assessment of land revenue.
4. They are equally helpful to the farmers in developing soil conservation consciousness in them and an urge for bunding their fields.

(Received: 27th July 1957)

FLOOD CAUSES ARMY-WORM OUTBREAK

By M. Puttarudriah[1] and S. Usman[2]

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I. Introduction

During September–October 1956 there were heavy rains (22·18″ from September 18th to October 17th) which resulted in the breach of one of the major tanks in the State, at Kunigal, on 17th October 1956. A couple of weeks later vast numbers of the army-worm caterpillars, *Leucania* (= *Cirphis*) *unipuncta* (Haworth) (Noctuidæ, Lepidoptera), suddenly appeared in the Kunigal tank and channel bed areas and attracted attention because of the extensive damage they caused to sugarcane. Probably the flow of water at 10–15′ level might have initially carried them and left them on sugarcane plants on which they could catch. They apparently favoured sugarcane and fed voraciously on the green leafy portion leaving only the mid-ribs of the leaves erect (Fig.). However, they occurred in highly localised patches long distances apart, and before they could spread to new areas, intensive control measures were undertaken and the pest was effectively controlled.

---

[1] Government Entomologist, Mysore Department of Agriculture.

[2] Senior Assistant Entomologist, Mysore Department of Agriculture.

II. Past History

Reports are on record (unpublished) of a similar sudden attack by the army-worm on a wider scale extending over Kunigal, Tiptur and Tumkur Taluks of Tumkur District; Magadi, Doddaballapur, Devanahally and Bangalore in Bangalore District and Mulbagal and Kolar in Kolar District during October–November 1929. The standing cereal crops were damaged. The pest declined during the following year, and the insect attracted no attention in the subsequent years.

In recent years two severe outbreaks of the army-worm on sugarcane were reported from India. *First*, an attack on sugarcane grown in the beds of the rivers *Panchaganga* and *Krishna* in Kolhapur and Ugar in Bombay State early in August 1950; (Wagle, 1951) and *the second* on Pusa Farm, Bihar, during August 1953 (Butani, 1953). In both these cases the infestation was noticed immediately after the receding of floods from the cane fields, and the damage to the crop was similar, namely, an almost complete defoliation.

Similar outbreaks of this pest were reported in the past on paddy from Assam in 1916 (Fletcher, 1917) and on *Jowar* from Burma in 1922 (Ghosh, 1924).

III. Distribution

The army-worm occurs throughout India. It was first reported from Patna in 1889 (Coates), and subsequently from Bengal (Coates, 1891–93), Uttar Pradesh, Poona (Barlow, 1928) and Madras (Fletcher, 1917).

It has a worldwide distribution, being recorded from North America, Canada, Hawaii Islands, Argentina, Australia, New Zealand, Fiji Islands, New Guinea, China and Siam (Evans, 1952 and Davis and Satterthwait, 1916).

IV. Host Plants

This is the first time the army-worm has attacked sugarcane in Mysore. This was no doubt the most favoured host and the caterpillars fed greedily on the succulent leaves. The pest was also present on the paddy crop in the midst of sugarcane but the damage was slight. In the dry areas ragi, *jowar* and grasses were infected.

During the 1920 outbreak the crops attacked were ragi,[3] *same*,[4] *navane*[5], *jola*,[6] paddy and grasses.

---

[3] Finger Millet, *Eleusine coracana*.

[4] *Panicum miliare*.

[5] Italian Millet, *Setaria italica*.

[6] *Jola, Jowar, Sorghum vulgare*.

Among the hosts of the army-worm in other parts of India are included *jowar*, maize, wheat, oats and pea, but it has often been a major pest of paddy and sugarcane (COATES, 1889, 1891–93 and FLETCHER, 1917).

Similar hosts have been recorded from other countries also (EVANS, 1952).

V. NATURE AND EXTENT OF DAMAGE

Generally the green leaf blades except mid-ribs were devoured in sugarcane, ragi, *jowar*, paddy, etc., and since the caterpillars were very abundant, every blade of each plant was eaten up in a severely infested area. The grass blades were fed upon entirely. The immature ragi earheads also did not escape; but in the more advanced crop the earheads were but partly eaten. The caterpillars are known to cut off the just ripening paddy ears, but such a damage was not actually seen in the present outbreak.

During the outbreak of 1956, 100 acres of sugarcane, 50 acres of paddy, 100 acres of ragi, *jola*, etc., were severely affected in Kunigal and Magadi Taluks. The crops were completely defoliated. However, since the crops were all grown-up and about to be harvested the economic loss, if any, was negligible.

In the 1929 outbreak about 33% of the ragi crop and 42% of *same* crop were affected. The extent of the loss depend on the stage of the crops at the time of attack. Those crops that were fairly advanced escaped or were harvested early to save further loss. The more immature crops suffered badly, the damage amounting to very nearly the whole crop in the worst cases.

VI. FACTORS INFLUENCING SUDDEN LARGE-SCALE OUTBREAKS

The army-worm is a good example of an insect of minor importance normally found in small numbers but which appears as a sporadic local pest only in certain years. It displays the remarkable habit of abnormally multiplying and appearing suddenly only in years characterized by a long period of drought followed by unexpectedly heavy late rains, a condition which was found in Mysore at the time of the outbreaks both in 1929 and again in 1956; this is the condition associated with the appearance of the army-worm in several other countries.

The army-worm is known to be a general feeder in meadows near swamps where the grass is rank (FERNALD, 1914). Under conditions of a fairly high temperature and a humid atmosphere this insect increases rapidly. Consequently, if there are late rains and if the weather is warm, the moths find the conditions eminently favourable for them and each

lays a large number of eggs; perhaps some hundreds. These hatch out in two or three days and the little caterpillars migrate in search of food and swarm wherever succulent young crops are abundant in the neighbourhood. They are full grown in about three weeks and the moths emerge a week or so later. Thus the caterpillars increase very rapidly and the *ryots* find their fields suddenly invaded by great armies of them and wonder where they came from.

Soon, however, colder, drier weather sets in, the food supply begins to give out, parasites, predators and diseases multiply, and the pest population dwindles just as rapidly as it grew. *But they are not all wiped out.* In favourable areas some of them survive and carry on unnoticed in the normal manner. Instead of a ravenous army devouring the crops, there is only an occasional caterpillar here and there and nobody pays them any heed. Sooner or later—it may be years later—the combination of favourable conditions occurs again—late rains, warm weather and young succulent crop and grasses, and lack of natural enemies, and the *mystery* worm swarms once more, for a brief period, in its millions, until nature can catch up and restore the balance again. It is believed that the moths migrate in large numbers at night from infested areas to lay their eggs in some distant areas, which perhaps accounts for the discontinuous distribution of the pest in isolated patches in an infested locality.

VII. Description of Stages

Davis and Satterthwait (1916) have given detailed descriptions.

The Egg.—(0·5 mm.). Smooth, shining milky white changing to gray, with very fine reticulations (visible only under high power); spherical, compressed on top and bottom. Laid in rows or in masses of 20–76 between overlapping leaf-sheaths and fixed to the leaf by means of a glutinous secretion which when dry is white and flaky. Each moth may lay 1–4 such egg-masses.

The Larva.—Newly hatched 2 mm., full grown 35 mm., head pale brown, body whitish turning greenish after feeding, with long fine hairs which are blackish on the dorsum and whitish on black tubercles on the sides. As the larva develops, the head becomes dark brown, the ground colour of the body greenish, paler posteriorly, with a whitish median dorsal line and seven alternate reddish brown and white longitudinal stripes on each side; ventral surface white. The first pair of abdominal legs somewhat reduced, which accounts for the characteristic looping movement of the first and second instar larvæ.

Generally the larvæ moult five times and in occasional cases six times before they develop into full grown larvæ. The development

through the different instars is accompanied by the gradual increase in size and certain marked changes in the colour-pattern of the body as noted below:

2*nd Instar Larva.*—The body gradually narrows posteriorly, colour-pattern as in the previous instars.

3*rd Instar Larva.*—Head amber brown with dark markings; the general body colour greenish, the 2nd dorsal brown band broken into two brown bands and one whitish band, the 3rd brown band with a paler line along its median, and the brown band at base of legs almost obliterated. The abdominal legs fully developed.

4*th Instar Larva.*—Characterised by a pale yellowish brown body; the colour of the longitudinal stripes becomes intermixed and less distinct, the spiracular stripe white with interrupted reddish line; spiracles black, surrounded by conspicuous whitish areas, those on prothoracic and proanal segments largest.

5*th Instar Larva.*—Just below the line of spiracles is a narrow white stripe followed by another narrow line of burnt red; the underside of the body cream-coloured or faint greenish; dorsal surface appearing mottled with brownish markings on a pale or cream-coloured background. Later the entire body appears dirty dull green with pink tint darkest along median dorsal lines thus almost obliterating the lines. Spiracles velvety black.

6*th Instar* (*Full Grown*) *Larva.*—Head grayish brown with dark reticulations. The general body colour varies in different individuals, some being dirty pale brown, while others appear very dark and in some cases even almost velvety black. A median dorsal line, dark brown, interrupted by narrow white dashes and interfused with pale lines on the margins. Laterally a dark brown stripe followed by a white stripe, and this is followed by another dark brown stripe just above the line of spiracles. Below the line of spiracles is a yellowish stripe with a pinkish tint, contrasting with the dark brown line above and the dusky brown area beneath. Body sparsely covered with fine hairs placed on minute black tubercles.

The Pupa (20 mm.).—Smooth, shining dark brown, obtect. A cremaster with four spines, two median prominent and robust, and a slender shorter hook-like spine on each side of the larger ones. The pupa is at first cream-coloured and then changes to brown. Pupation in an earthen cell in the soil or naked inside the leaf-sheaths on the plant.

The Moth (Expanse 44·5 mm.).—Pale brown with dark specks and blotches. Fore-wing with slight traces of kidney-shaped stigmata;

a minute white speck about the middle with a black speck inside it; and an indistinct oblique streak. Hind-wing pale with a reddish tinge, underside sometimes with faint spots in the middle and series of specks post-medially. The male moths are smaller and are lighter in colour than the female moths.

VIII. Life-History and Habits

The Life-History.—The life-history of the army-worm has been worked out in the laboratory. The main facts are summarised below:—

(*a*) *Individual rearings*:—

Eggs laid	8·XII	Incubation period	6 days
Hatched	14·XII		
1st moult	17·XII	1st instar	3 days
2nd moult	22·XII	2nd instar	5 days
3rd moult	28·XII	3rd instar	6 days
4th moult	3–1	4th instar	6 days
5th moult	10–1	5th instar	7 days
Pupation	14–1	6th instar	4 days
Moth emerged	22–1	Pupal period	8 days
		Total larval life ..	31 days
		Total life-cyle ..	45 days

(*b*) *Mass rearings* (*Average of* 50 *caterpillars reared*):—

Egg laid Hatched	Incubation period	4·5 days
Larval period		22·5 days
Pupal period		8 days
	Total life-cycle ..	35 days

In series (*a*) the development took place in an unnatural condition as there was constant disturbance during daily examination. This no doubt prolonged the life-cycle. The development in series (*b*) represented more closely the conditions in nature. Probably in the field conditions the development may be still faster owing to more favourable environmental factors, which are associated with sudden increase of insect population resulting in serious outbreaks of the army-worm.

General Habits.—Newly hatched larvæ of an egg mass on a leaf usually congregate together, scrape the surface of the leaf and feed on the green matter, the other surface being left as a transparent membrane. When disturbed the young larva curls up and drops down by means of a silken thread, remains inactive for a moment before attempting to crawl away. The first and second instar larva crawl about with a looping movement, but this characteristic is lost in the third and succeeding instars.

The older larvæ feed from the edge of the leaf, devouring all the leaf tissue, except the mid-ribs. More than 80% of all the foliage eaten during the entire life of the larva is consumed during the last larval instar, which explains the fact that the army-worm rarely becomes evident and destructive until the caterpillars are nearly full grown. The larvæ are active and feed in the nights. In the daytime they rest usually under the leaves, or under the shade on the ground round about the plants. In the sugarcane and paddy fields, where the ground is wet, they seek shelter in the whorls of tender leaves; as many as from 5–20 larvæ may be found inside each whorl of sugarcane. The caterpillars are found usually at first in one portion or along one side of a field, but they spread to the entire field damaging every plant. On disturbance they drop down on the ground, curl up and feign death.

The mature larva stops feeding, the alimentary tract is soon emptied and it shortens up to a marked degree. Normally it burrows into the soil, to a depth of $\frac{1}{2}''$–$1\frac{1}{2}''$ and pupates there in an earthen cell. The larva spins silk as a lining for its cell. Pupation may also take place under the trash. When there was standing water round about sugarcane or paddy plants, the pupæ were found on the plants themselves inside the leaf-whorls, in cells constructed out of their excreta. In the laboratory naked pupæ were obtained in glass containers when sand was not provided.

The moths are also nocturnal in habit and hide during the daytime under leaves and other shady situations. When disturbed they make short flights. They are known to feed on the honey-dew secreted by the mealy bugs, scale insects, etc. Here they are observed to visit the over-ripe lantana berries and feed on the juices. In the laboratory they fed greedily on dilute honey, thick sugar syrup and molasses.

IX. Natural Enemies

Parasites.—An Ichneumonid and a Tachinid parasites (still to be identified) have been obtained from the caterpillars collected in the sugarcane fields.

Birds.—In the fields certain birds were found devouring the army-worm caterpillars. These were crows, sparrow (*belavn*), and *mynah.*

X. Control Measures

Trenching, mechanical collection, traps, baits and arsenical sprays, etc., were reported against the army-worm in the past. More recently BHC, DDT, Aldrin, Dieldrin, Toxaphene and Parathion have been found to be quite effective against this pest.

FIG. 1

Canes attacked by Army Worm Caterpillar

In the recent outbreak at Kunigal and Magadi the army-worm pest was completely controlled at the initial stage itself by the use of the following chemicals:—

1. HEXAMAR 10% at the rate of 10–12 lb. per acre on ragi.
2. FOLIDOL E. 605, 7½ c.c. in 4 gallons of water on sugarcane.
   FOLIDOL E. 605, 5 c.c. in 4 gallons of water on paddy.
3. DDT 50% wettable, 1 lb. in 16 gallons of water on paddy.
4. Calcium arsenate, 1 lb. with 2 lb. of lime and 3 lb. of jaggery in 30 gallons of water on sugarcane.
5. Sodium silicofluoride 1 lb. in 8 *seers* of bran and 2 lb. of jaggery, as bait in sugarcane field.

All these treatments were quite effective.

It seems desirable to keep a watch on this insect whenever favourable conditions for its rapid development arise, namely dry weather followed by heavy rains in September and October and adopt control measures at the earliest stages in its swampy haunts from where the pest originates.

XI. ACKNOWLEDGEMENTS

The prompt control measures and co-operation by the district staff of Tumkur and Bangalore and the Agricultural Inspectors and their staff at Kunigal and Magadi in the effective control of the pest at the initial stages may be placed on record. Thanks are due to Sri. P. R. Raghuram Pillai, Artist and Photographer, for the diagrams.

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SORGHUM (*KHARIF*) CULTIVATION AND ITS PROBLEMS IN THE TUNGABHADRA PROJECT AREA

By S. B. Priyavratha Rao[1]

Watts (1908) recorded that *Sorghum vulgare* (*Andropogon sorghum*) is a tall handsome grass, cultivated throughout India since very remote times. Among millets, Sorghum is called as the great millet in view of its importance in respect of area and production, as well as size of plant and grain. Sorghum is an important crop of the Deccan Plateau in general and the Ceded Districts in particular. Nearly 6–8 lakhs of acres are sown to Sorghum every year in Bellary District itself. At present, Sorghum is raised mainly under rain-fed conditions. In light and mixed soils, it is grown as a *Kharif* (early season) crop and in heavy deep soils, it is raised during the *Rabi* (late season). Like any other small-grained cereal, Sorghum thrives well in low rainfall areas and also under poor fertility conditions. The yield of grain and straw of rain-fed Sorghum in this tract, varies from 350 lb. to 500 lb. and from 800 lb. to 1,500 lb. respectively. Though Sorghum is mainly raised as a dry crop, it however responds very well to manure and irrigation. Under good management, the irrigated yields are nearly three to four times those of dry lands.

The monsoon rains being very erratic and ill-distributed, frequent crop failures are not uncommon in this tract. To prevent crop failures and combat the consequent famines on a permanent footing, the waters of the Tungabhadra river have been harnessed for providing irrigation facilities to the lands situated in the Districts of Raichur, Anantapur, Cuddapah, Kurnool and Bellary. The localisation technique adopted in the Tungabhadra Project is rather unique in the sense that more prominence has been given to *dry irrigated-crops* (*e.g.*, millets, pulses, cotton, oilseeds, etc.) than wet-land crops like paddy and sugarcane. Nearly two-thirds of the total *ayacut* (command) area[2] is aligned for dry-irrigated crops only.

S. No.	District	Low level canal (Area in acres)	High level canal (Area in acres)	Total
1	Bellary ..	0·93	1·56	2·49
2	Raichur ..	..	..	5·70
	Total ..	..	..	8·19

[1] Assistant Cotton Specialist, Siruguppa.

[2] Estimated area under Tungabhadra Project in New Mysore State.

Among the food crops that are to be raised in dry-irrigated zone, Sorghum (*jola*) is the chief millet which tops the list both in acreage and production. Nearly two lakhs of acres are to be grown to Sorghum every year, half the area being in the early season and the rest in the late season. The cultivation of Sorghum in the *Kharif* season in the Tungabhadra Project area and its problems are discussed in this paper.

Earlier trials at the Agricultural Research Station, Siruguppa, revealed that Sorghum as an irrigated *Kharif* crop gave high and remunerative yields. The cultivation details in brief are as under. The field is thoroughly ploughed and harrowed. To facilitate irrigation, the field is divided into small rectangular plots by working a bund-former. The main and cross-channels are formed by working a ridge-plough. The bunds are then strengthened. The beds and channels are rectified with *mammaties*.[5] The manure (ammonium sulphate at 40 N per acre) is drilled with *akkadies* (seed hopper) and then covered by passing a *Guntaka*.[3] (If cattle manure is available, it may be applied with advantage at the rate of 5–10 cart-loads per acre before the second ploughing is done. This is in addition to the ammonium sulphate dose suggested.) The seeds are drilled and covered. A seed rate of 10–12 lb. is used per acre. (Seeds are to be treated with either sulphur or AGROSAN G.N. before sowings, as a prophylactic measure against smut disease. It costs only 4–6 pies to treat 10–12 lb. of *jola* seeds.) The crop is intercultivated once or twice with *danthies*[4] to keep down the weeds. Irrigations are usually given at two-acre-inches once a fortnight. In normal seasons, a *Kharif* crop comes to maturity with 4–5 irrigations in all. The crop is generally sown in June–July and comes to harvest by October–November.

A large number of types—(both provincial and extra-provincial)—were tested at the Agricultural Research Station, Sirguppa. The results go to show that Co. 9 (called as *Kesari* or *chitrai cholam*) from Coimbatore has been found to be most suitable for raising in the Project area. Its performance for the past five seasons are presented in Table I.

It is seen from the figures presented in Table I. that the yields are really encouraging and also remunerative. In view of the above, Co. 9 variety of *jola* has also been distributed to the *ryots* during the year 1954, for growing in the Tungabhadra Project area. It is reported by the extension staff, that Co. 9 *jola* has found favour with the *ryots*. The area under Co. 9 is also on the increase in subsequent years.

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[3] Blade harrow.

[4] Hoe.

[5] Spade.

TABLE I

Performance of Co. 9 (under irrigation) at the Agricultural Research Station, Siruguppa

S. No.	Year	Acre yields (in lb.)	
		Grain	Straw
1	1952–53	1,884	2,546
2	1953–54	1,432	6,258
3	1954–55	2,189	3,922
4	1955–56	880[6]	2,001
5	1956–57	1,376	2,612
	Average for 5 years	1,552	3,468

The grain of Co. 9 *jola* is dull-white in colour with a pinkish wash, as against the pearly-white grains of late season types. Pearly-white-grained varieties are in great demand in this tract. These also fetch a premium in the market over other types like yellows, reds, browns, or chalky whites. Co. 9 *jola* being short in duration, the out-turn of straw is low. Further, the straw being pithy in nature, is only second in quality to the *Rabi* varieties which possess sweet and juicy stalks. In addition, Co. 9 in view of its short duration, more often gets caught in the rains during the ripening stages of crop growth. Consequently, the quality of the grain is invariably spoiled. The grains turn black and mouldy. In heavy rainfall years (*e.g.*, 1954–55 and 1955–56) the grains were observed to germinate in the ear itself. There is no market for mouldy grain. The viability is also likely to be lowered if the grains become mouldy. A change in the planting date with Co. 9 has not yielded any useful results. It is thus seen, that Co. 9 variety requires improvement in respect of both grain and straw qualities. The duration of Co. 9 also needs alteration to evade rains during the ripening stages, in order to maintain the quality of the grain at a high standard.

Improvement work on Co. 9 *jola* has now been taken up as a fresh problem at the Agricultural Research Station, Siruguppa. A large

[6] During 1955–56, the crop yields were low due to very heavy rains.

collection of local types are being made and tested here for further selection. In addition, new standard strains evolved by the neighbouring States (Hyderabad, Bombay, Andhra and Madras) are being tested at Siruguppa, with Co. 9 as the standard. Results gathered from these preliminary trials have shown that types like Co. 7 and A.S. 8159 (from Coimbatore) and D. 340 (from Composite Hyderabad) have fairly come up to our expectations. A summary of the data gathered in this branch of study is presented in Table II.

TABLE II

Plant characters of improved types

S. No.	Particulars	Co. 7	Co. 9	D. 340
1	Height of plants (cm.)	246·0	204·0	256·0
2	Number of leaves	9·6	8·4	11·3
3	Length of 4th leaf (cm.)	71·8	60·8	68·1
4	Breadth of 4th leaf (cm.)	5·4	5·2	5·9
5	Thickness of 4th internode (cm.)	1·6	1·2	1·5
6	Length of peduncle (cm.)	33·2	32·8	35·5
7	Length of panicle (cm.)	10·9	9·3	14·6
8	Breadth of panicle (cm.)	6·3	5·7	6·7
9	Nature of panicle	Semi-compact	Compact	Loose
10	Mid-rib colour	White	White	Dull
11	Grain colour	Pearly white	White with a pink wash	Pearly white
12	Grain size	Medium bold	Small	Bold
13	Duration in days	115–120	105–110	120–130
14	Grain yield per acre (lb.)	1,588*	1,658*	1,510†
15	Straw yield per acre (lb.)	4,706*	3,746*	5,594†

N.B.—Average of 25 plants have been furnished in respect of plant measurements noted against items 1–12.

* Average of 5 seasons.

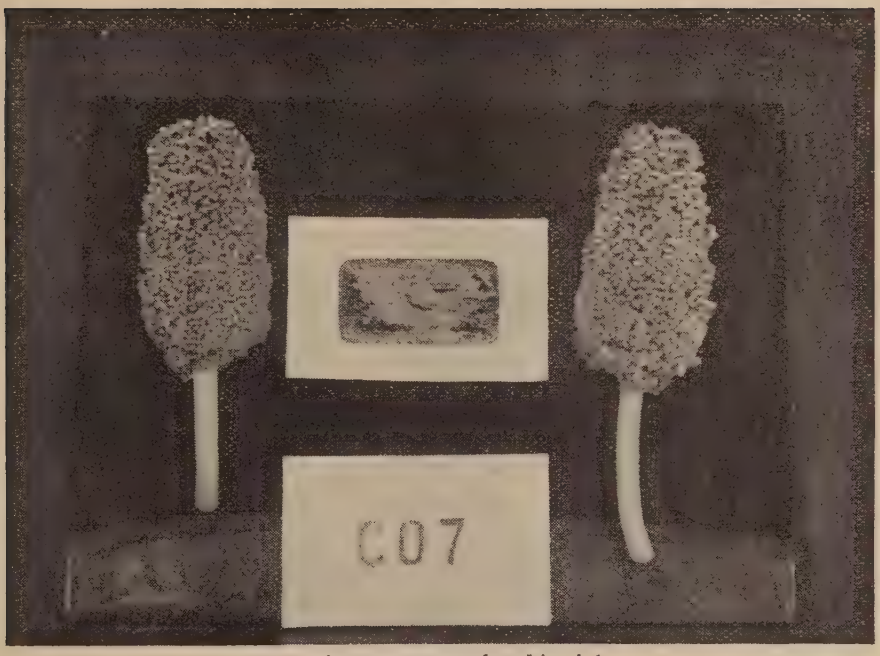
† Yield figures recorded during 1956–57 only.

It is seen from the above figures that Co. 9 still holds the field, so far as the grain yield is concerned. Though Co. 9 has registered numerically higher grain yield than the rest, the yield differences between the strains under test never reached the level of statistical significance. Co. 7 and D. 340 being late in duration were able to escape the late rains quite successfully. These types possess better grain colour than Co. 9 —(*i.e.*, pearly-white) and are on par with *Rabi jowars* for this attribute. In addition, they are also higher straw yielders than Co. 9. Further, D. 340 is of the juicy and sweet stalked type as against the pithy straw of Co. 9. The earhead and grain samples of Co. 7, Co. 9 and D. 340 are shown in the photograph.

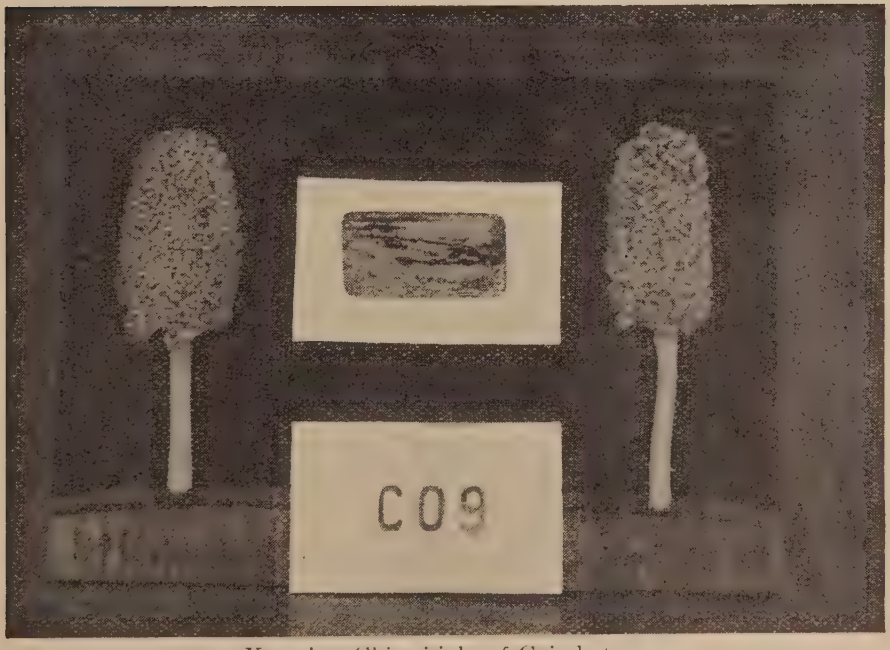
WATTS (1908) reported that in a very general sense, there are two great crops of *jowar*. Of these, one is the *Kharif* which ripens in autumn (September–October). The majority of the *Kharif* forms would fall under the botanical varieties of " bicolor " *cernums*; and *vulgaris* proper. The second crop is the *Rabi* or that ripens in spring (January–February). Most of the races placed in this category come under the varieties *hians*, *Roxburghii* and *Saccarttus*. As a rule, the best kinds are creamy white and are of pearly lustre. *Kharif* varieties are much more numerous than *Rabi* varieties. Early or late varieties do best only if sown at their approximate seasons. Thus, a *Rabi* variety with good qualities of grain and straw may not thrive if sown as a *Kharif* crop and none of the early varieties have fared well when sown in the *Rabi* season. Thus, it is evident that the types of *jola* raised in the early and late seasons are quite distinct. There are also two main types of *jola* with regard to stem type character, *viz.*, (i) the pithy or the dry stem and (ii) the juicy and sweet stem. The stalks of the latter are better relished by the cattle as these are highly palatable. In roughages, palatability is one of the chief factors that helps to minimise wastage of fodders. The dominance of white mid-rib with pithy stalk to that of dull mid-rib with sweet-stalk has been recorded by earlier workers. Most of the *Kharif* varieties as a class are of white mid-rib types, while the *Rabi* varieties possess mostly dull mid-ribs.

Jowar is normally grown as a dual purpose crop for grain and fodder. The grain serves as a very sustaining food[7] for men and the straw provides a nutritious fodder for cattle. Relatively to grain, *jowar* gives a higher amount of straw than any other cereal crop. Sorghum

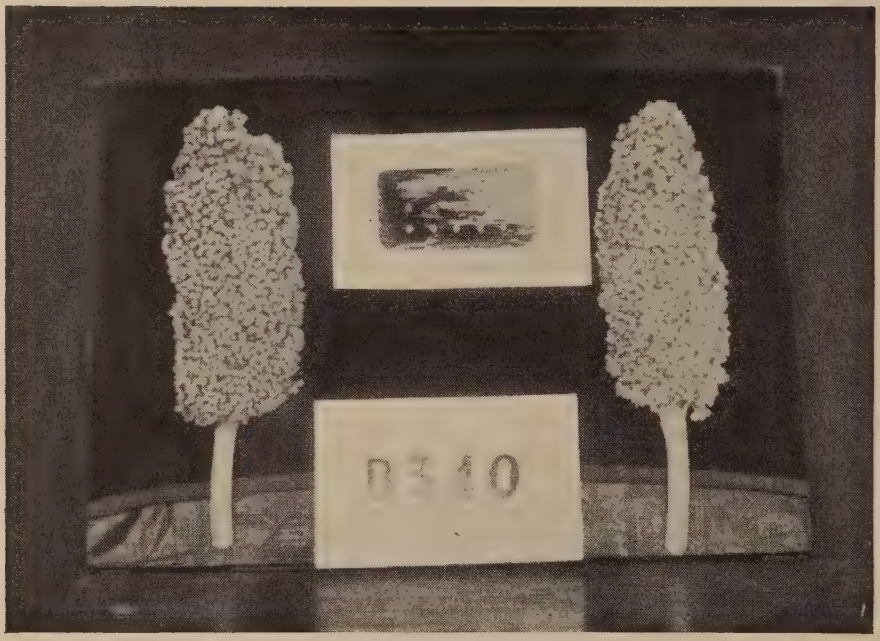
[7] Rao, P. K. (1946), reported that in food value *jola* is richer than rice in protein and also contains more fat than both rice and wheat. *Jola* grain is mostly used for making bread (*roti*). It is also consumed in many different ways (*e.g.*, *Anna*, *Ganzi*, *Dosai* and *Iddali*, etc.). *Jola* grains of some varieties make excellent pops. These pops are consumed in various forms. *Jola* grains are also used for preparing malt foods and malt extracts.



Semi-compact pearly white jola



Kesari or Chitrai jola of Coimbatore



Hyderabad loose pearly white jola

straw as a class is superior to that of paddy. Therefore, *jowar* is also very valuable in animal husbandry as well. Aykroyd (1941)[8] reported that *jola* possesses higher biological value of proteins than rice and wheat and hence it is classed as superior in food value to other cereals.

It is seen from the foregoing paras, that the *jowar* type needed for the Tungabhadra Project area must possess better qualities of grain and as well as straw. It should evade the late rains during the ripening stages to maintain the lustre of grain. In addition, it must be a prolific yielder of both grain and straw. Data on hand go to show, that no single variety possesses all the desirable characters. Therefore, the problem resolves itself into one of combining the good qualities found in *Kharif* (high yield) and *Rabi* (quality of grain and straw and lateness in maturity) types, in one and the same strain. The only method to achieve this objective is by way of hybridization and further selection. Varieties possessing one or more of these attributes are on hand. Attempts are underway to combine all the economic attributes in one strain, suitable to the Tungabhadra Project area. In the meanwhile, it is also planned to test these new types—*viz.*, Co. 7, D. 340 and A.S. 8159 along with Co. 9 in the *ryots* holdings during the coming season, to assess their performance under varied conditions of soil and cultivation practices.

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(Received: 15th April 1957)

[8] Cereals — Biological value of proteins

Jola ..	83
Rice ..	80
Wheat ..	67

CARCELIA EVOLANS KOCKIANA TNS. (TACHINIDÆ, DIPTERA), A NEW PARASITE OF THE LAB LAB PODBORER, *ADISURA ATKINSONI* MOORE (AGROTIDÆ, LEPIDOPTERA)

By M. Puttarudriah and G. P. Channa Basavanna[1]

The authors (1956) recorded three hymenopterous parasites as attacking the larval stage of the lab lab podborer, *Adisura atkinsoni* Moore, a serious pest of the field bean, *Dolichos lablab* in Mysore State. Subsequently another parasite, *Carcelia evolans kockiana* Tns. (Fig. 1)—a tachinid fly—has been noted to parasitise the larvæ of the podborer. The percentage of parasitisation has been observed to be low (not more than 2·5%) and the incidence of the parasite in the fields generally becomes evident during the latter part of December, in January and February, *i.e.*, towards the end of the season for lab lab crop.

Carcelia evolans Wd. has not been reported from India. But *Carcelia kockiana* Tns. has been reported (Beeson and Chatterjee, 1935) as a parasite of a number of lepidopterous caterpillars from different places in India, and to be widely distributed in the Oriental Region. Mathur and Beeson (1942) have given a larger number of lepidopterous hosts of this parasite both in South and North India. It may be that *C. cockiana* and *C. evolans kockiana* may be the same. Garthwaite and Desai (1939) have given the life-history of *C. kockiana*.

The symptoms of parasitisation are not apparent in the early stages; but before the parasite maggot emerges out of the host caterpillar, the latter becomes inactive and appears as almost dead (Fig. 2 *a*). The whitish plumpy maggot emerges out of the host larva, usually from one of the lateral sides (Fig. 2 *b*) and pupates in dark brown barrel-shaped puparium (Fig. 2 *c*). Only one maggot is noted to develop in a single host caterpillar. The puparia may be found within the infested lab lab pod or on the soil or within the soil just below the surface. The fly emerges by cutting open one end of the puparium. The fly is greyish with the posterior margins of abdominal segments black, and measures 7 mm. to 10 mm. long (Fig. 1). The fly is active soon after emergence and flies about in the breeding cage.

The writers are thankful to the Director, Commonwealth Institute of Entomology, London, for the identification of the parasite.

[1] Division of Entomology, Mysore Department of Agriculture, Bangalore.

FIG. 1. *Carcelia evolans kockiana* Tns. adult.

FIG. 2. Parasitised lablab podborer larvæ (*a*), podborer caterpillar showing hole through which parasite maggot has emerged out (*b*), and parasite—puparia (*c*).

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UREA

By K. L. Bhatta[1]

Urea is a well established commercial fertiliser, which has only recently been introduced into the Indian market. It is a rich source of readily available nitrogen containing as it does 45% by weight of this valuable plant nutrient. The limited stocks now available in the Indian market are mainly imported from abroad but Indian manufacture of this important fertiliser has been planned at Sindhri and elsewhere and expected to be in the market during the course of the year.

Hitherto, the Indian farmer obtained his supplies of mineral nitrogen mainly in the form of ammonium sulphate, to the use of which, he is now quite well accustomed. But, to the discriminating farmer, who prefers quality to bulk, urea offers certain advantages over ammonium sulphate. Firstly urea contains 45% of nitrogen as against 20% in ammonium sulphate. In other words 4 maunds of urea supplies to the soil the same amount of nutrient as 9 maunds of ammonium sulphate, besides enabling the farmer to save 50% over transport and handling charges. At current prices, one pound of nitrogen as urea costs twelve annas against fourteen annas per pound of nitrogen as ammonium-sulphate. Therefore, urea is really the cheaper of the two fertilisers although bulk for bulk it costs more than ammonium sulphate. Another added advantage with urea is that it leaves less acid residues in the soil, and it is barely one-third as acidic to soils as ammonium sulphate.

In field tests carried out in Mysore during the past two years, urea has been found to be well suited to our conditions. These tests were carried out on the fields of cultivators in all districts and under all soil types. The total number of tests exceeded seven hundred. To assess their relative usefulness, urea and ammonium sulphate in quantities supplying the same amount of nitrogen, were applied to the crop and yields obtained in each case were recorded. In a larger number of cases, the yields with urea were better.

In its pure form, urea is a white crystalline solid, highly soluble in water and with a pronounced tendency to absorb moisture from humid air. The commercial product is usually granular, glazed and is often given a protective coating which reduces its sensitiveness to humid conditions and largely reduces its tendency to cake under storage. It is non-corrosive, easy and safe to handle and use.

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[1] Regional Officer, Fertiliser Demonstrations, Bangalore.

Urea can be used for nearly all crops for which ammonium sulphate is recommended. It can be applied either before sowing or as a top or side dressing after germination. Its high solubility in water and hygroscopic nature, render certain precautions necessary. For example, it should not be applied to fields in which water is standing or flowing in puddled paddy fields, as a good proportion of the fertiliser may be lost by leaching. The proper method is to apply it 2–3 days before water is allowed for puddling. When urea is applied before sowing, it should not be mixed with the seed, as this might interfere with germination.

To enable Mysore farmers to take advantage of this new fertiliser, the Department of Agriculture has arranged for supplies and put it up for sale at selected centres of the State.

(Recived: 29th August 1957)

S. 20–2: AN IMPROVED *BIDI* TOBACCO VARIETY FOR THE NIPANI TRACT

By K. A. Jalihal[1] and M. S. Krishna Rao[2]

The Nipani tobacco tract comprising Chikkodi, Hukkeri and Athani *taluks* of Mysore State and parts of Kolhapur and S. Satara districts of Bombay State, is the most important *bidi* tobacco area of India. Almost equal in area to the only other *bidi* tobacco tract of India, *viz.*, the Charotar tract, the Nipani tract ranks first in producing quality tobacco.

The area under tobacco in Nipani tract during 1954–55, the latest year for which statistics are available, is as under:

Mysore State			Bombay State		
Belgaum District,					
Chikodi Taluk	40,477	acres	Kolhapur District	42,275	acres
Hukkeri	14,018	,,	S. Satara	24,076	,,
Gokak	5,238	,,			
Athani	2,460	,,	Total ..	66,351	,,
Others	2,840	,,			
Total ..	65,033	,,	Total for Nipani tract	1,31,384	,,

The local varieties cultivated are known by various names but the important ones are (1) Surti, (2) Bhopli, (3) Baglani or Gunda. Surti is by far the largest variety under cultivation for the production of "Angal" or the powdered leaf used for the *bidi*. Bhopli is used for mixing with Surti while Baglani is mostly cultivated for chewing.

The varietal improvement work on *bidi* tobacco of Nipani tract was started with the establishment of a Government Tobacco Research Farm at Nipani in 1938.

The initial work was mostly restricted to selection breeding and as a result of research work carried out over a decade, an improved type for the area which grows Sutri type was evolved. This improved strain is named as S. 20–2 and gives an increased yield over the local from 15–30% and is far superior in quality than the local type. The notable character of this improved variety is the production of a good number of spangles on red spots (popularly known as eyes) on the leaf surface.

[1] Agronomist, Agricultural Research Station, Nipani.
[2] Agricultural Officer, Agricultural Research Station, Nipani.

Some of the important morphological characters of this improved strain are as follows:

1. Average height of untopped plant .. 38″
2. Average girth of stem at nipping point .. 9 cm.
3. Average internode length .. 4·2 cm.
4. Average length of leaf .. 66 cm.
5. Average breadth of leaf .. 30 cm.
6. Days to flower .. 120
7. Number of days for the topped plant to ripen 180

The performance of the improved strain on the research farm at Nipani and in the cultivator's fields in the district are tabulated below:

(*A*) *Performance of S.* 20–2 *on the farm: yield of dry leaf in lb.*

Year	S. 20–2	Local	% increase than local
1945–46 ..	820	750	10
1947–48 ..	710	575	23
1948–49 ..	760	560	35
1949–50 ..	870	850	3
1950–51 ..	690	660	5
1951–52 ..	750	670	12

(*B*) *Performance of S.* 20–2 *in the districts*

Village	Local	S. 20	% increase over local
(*a*) 1950–51			
Haroli ..	880	1,040	18
Jayasingpur ..	800	1,200	50
Shirol ..	1,160	1,280	10
Akkol ..	640	720	12
Mamadapur ..	740	850	14
(*b*) 1951–52			
Haroli ..	720	1,120	55
Dattwad ..	600	680	13
Akkol ..	240	320	33
Mamadapur ..	640	720	12
(*c*) 1952–53			
Hasur ..	640	420	43
Narasobbad ..	560	920	64
Takawade ..	600	760	26
Yaranal ..	480	580	21
Hirekodi ..	400	480	20
Hattaragi ..	406	530	30

Seed Multiplication and Distribution.—The improved variety is under multiplication at the Nipani Farm and this multiplied seed is being distributed to the cultivators. The seed multiplied and distributed during the last two years is shown below:

	Seed multiplied and distributed in lb.	Approximate area covered in acres
1954–55 ..	125	2,500
1955–56 ..	250	5,000

As the area on the Farm itself is not sufficient for seed multiplication a separate scheme for seed multiplication in the cultivators' fields by giving them subsidy is under consideration.

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STUDIES ON THE BIONOMICS OF THE PADDY GALL-MIDGE—*PACHYDIPLOSIS ORYZÆ* (W.M.) MANI

By D. V. Murthy[1]

I. Introduction

The Paddy Gall-Fly, *Pachydiplosis oryzæ*, is one of the important insect pests in the Indian Union. It has been recorded practically in almost all the rice-growing areas. Outside India, it is found in Ceylon, Burma, Siam, China and many other countries.

Synonymy and Common Names

The insect was first described by Wood-Mason who proposed the name *Cecidomyia oryzæ* but published no description. Subsequently Felt identified it as belonging to the genus *Pachydiplosis* Kieff, and assuming that it was identical with Wood-Mason's *Cecidomyia oryzæ*, called it *Pachydiplosis oryzæ* Wood-Mason. As both the above authors had not published any description of the insect, Mani (1934) undertook the description of the midge in detail but however retained the original name itself, since it is a well-known name to other workers. Yen *et al.* (1941) also have given descriptions of the different stages of the insect but the account is in Chinese language.

In India, the insect is known by a number of popular names—'Silver-shoot', '*Anekombu*', '*Nolla Mado*', '*Kane*', '*Kodu*', '*Koyya*', '*Koyya Dumpa*', '*Gangai*', etc.

Economic Importance

The effect of the gall-midge on rice crop is the formation of galls instead of the normal panicle-bearing stems. These galls are termed as 'Silver-shoots'. It is reported that this midge causes considerable losses in certain parts of Madras and Bombay (Padwick, 1948). It is also observed as a major pest of rice crop in Madhya Pradesh, Bengal and Orissa (Narayanan, 1953). Ramachandra Rao (1926) mentions that *Pachydiplosis oryzæ* causes severe damage in South Kanara district and in all the northern *talukas* of Malabar and that in bad years, the total damage may amount to 75% or even more. Hegdekatti (1927) reports that in Bombay State, the pest is known to occur widely in South Konkan, North Kanara and Ratnagiri and that in 1925, over 25% of

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rice crop was reported as attacked by this midge in Kumpta. According to USMAN (1954) *Pachydiplosis oryzæ* is a highly localised pest and is occasionally serious in Mysore, Shimoga, Kolar and Hassan districts. According to BARNES (1956), an outbreak of gall-midge occurred in Mysore State in 1933–34. KHAN AND MURTHY (1955) report that *Pachydiplosis oryzæ* is an important insect pest of rice crop in Nizamabad district of the present Andhra Pradesh. Some of the endemic areas in Telangana region of Andhra Pradesh are Banswada *taluka* in Nizamabad district, Khanapur *taluka* in Adilabad district and Mahaboobabad *taluka* in Warangal district. In 1947, there was a severe outbreak of this pest in Nizamabad district of Andhra Pradesh and a random sample survey conducted revealed that nearly 30% of the area under the rice crop was affected. Outside India, NGUYEN (1922) records a loss ranging from 50–100% in some localities in Indo-China. YEN *et al.* (1941) in South China mention that sporadic outbreaks of this cecidomyiid occur in several provinces and considerable damage is caused to rice plants in all stages of growth.

The estimation of losses due to this insect pest is very complex. Preliminary observations conducted by the writer show that even if the mother culm is attacked there can be compensation by way of effective tillering. The late secondary and tertiary tillers, if attacked, do not in any way affect the final yield. If, however, both the mother culm and primary tillers are attacked there is bound to be a great loss in yield of grain amounting to more than 60%. This has been noted mainly due to a smaller number of mature earheads per unit that come up in the affected crop at harvest. The loss, as finally estimated by yield of grain, differs considerably in different varieties even if the incidence is the same.

DESCRIPTION AND MODE OF FORMATION OF THE GALL

In place of the normal stem, a hollow cylindrical gall is formed with a green tip. The colour of the gall may be dirty white or pale green or pink, depending upon the varieties. As a result of gall-formation, the apical growth ceases. After the emergence of the midge, the empty gall loses turgidity, becomes discoloured and falls off.

The gall-formation in rice is the result of feeding of the *Pachydiplosis* maggot at the base of the plant. It is still to be investigated whether gall-formation in rice is due to mechanical irritation as a result of feeding by the maggot or whether any chemical action is involved. DEORAS (1945) studied the mechanism of gall-formation and came to the conclusion that after attack, the closed leaf-sheath grows like an empty tube, carrying with it the blade, the auricles and the ligule. LI and CHIU

(1951) also opine that it is the leaf-sheaths and not the stem that form the gall.

Seasonal History, Biology and Habits

Seasonal history and biological studies of *P. oryzæ* have been carried out by Yen *et al.* (1942) in Kwangsi Province in South China. There are five generations in a year and the winter is passed in larval stage within rice stubble. The egg, larval and pupal stages last 3–4, 14–28 and 4–5 days respectively between July and October. The peak of abundance of adult midges are observed in early August. The number of eggs deposited by individual females average 131 and range upto 285. The longevity of adults varies from 1–3 days and the adults are active at nights. The eggs are laid singly and in groups on the leaves. Newly hatched larvæ are able to survive immersion in water for 2–5 days.

In Indo-China, Nguyen (1923) reports that the longevity of the adult midge is about 5 days and in captivity females oviposit on the stems of young rice plants.

In Nizamabad district of Andhra Pradesh, Khan and Murthy (1955) have studied the seasonal history of *P. oryzæ*. According to them, it is noted in a pest form in the first seasonal crop of rice grown between June and December and not on the second seasonal crop sown in January–February. The second week of July appears to be the normal appearance of the insect in a pest form on the crop. Two ' peaks' are observed in the incidence—the first one noted during the last week of August and the second one about 20 days later. The damage done by the maggots of the second ' peak ' is mostly to late secondary and tertiary tillers. The attack of the pest dwindles down from the first week of October. Stray galls continue to be observed however throughout October. It has not been possible to clearly mark out the broods as there is great overlapping of generations. The adults are short-lived (3–5 days).

During the second crop season in Nizamabad district, though the insect is not observed in a pest form, nevertheless, it is found in stray numbers. It is therefore concluded that atmospheric humidity plays an important role in the multiplication of *P. oryzæ*.

According to Gopalkrishnan *et al.* (1954) in South India, *P. oryzæ* is usually found in the first crop paddy (April–May to September–October), seldom on the second crop paddy (October–November to January–February) and never in the third crop (February–March to May). In the first crop of paddy the maximum percentage of Gall-fly attack

is found in the first week of September. SEN (1935) in Bihar states *P. oryzæ* lays its eggs on the leaves, on the stem and sometimes on the surface of the soil near the host plants. The incubation period lasts 2–3 days, larval period 5–6 days and the pupal period 3–4 days. The longevity of the adults varies from 2–3 days. The pest population reaches its maximum during the months of July–August. The pest has five broods in a year.

The entire larval and pupal period of *P. oryzæ* is spent in the gall itself. When ready to emerge the late instar larva works its ways up to the tip of the gall. An emergence hole is bored and the adult fly makes its way out. The empty pupal case is generally found sticking in the emergence hole. The larval and pupal period of the paddy gall-fly worked out by the writer at the Government Agricultural Research Station, Rudroor in Nizamabad district, during August–September was found to range from 8–15 and 2–6 days respectively.

PATEL AND BHATT (1954) in Bombay report that *P. oryzæ* often lays its eggs on the surface of water to a large extent and the maggots after hatching may float about for considerable periods before making their entry into the shoot.

The gall-fly adults are phototropic and could be attracted in numbers to a powerful source of light. BALLARD (1921), however, opines that it is the heat of the source of light and not light itself that causes the attraction of adult midges.

The adults are active at nights only. During daytime in laboratory cages, the adult midges are found resting. Egg-laying is also done in the night itself.

ALTERNATE HOST PLANTS

It cannot be stated with certainty that *P. oryzæ* has alternate host-plants. The writer during his twelve-year stay in the Nizamabad district of Andhra Pradesh where rice gall-fly is a common pest, has not found any other alternate hosts. It should be stated however that during an inspection tour of Khanapur *taluka* in Adilabad district of Andhra Pradesh in August 1956 he was able to collect galls on an unidentified grass growing in the paddy fields as well as on bunds, closely resembling paddy galls. The adult midges reared from these galls also resembled *P. oryzæ*. BARNES (1954) mentions that possible alternate hosts of *P. oryzæ* include *Panicum*, *Paspalum*, *Orphiurus*, and *Zizania*. In India, RAMACHANDRA RAO (1926) has recorded *P. oryzæ*, from *Panicum stagninum*. As stated by BARNES (1956) extensive rearings and experimentation are the only certain ways of determining the food-plant range. There are many other gall-midges which resemble *P. oryzæ* in external

appearance and also in the type of plant malformation they cause. According to Sen (1957), the following secondary hosts are known to be infested by *P. oryzæ* in Bihar, *viz.*,

1. *Hemarthria compressa* R.Br.
2. *Paspalum scrobiculatum* L.
3. *Oryza sativa* L. (Wild variety).
4. *Cynodon dactylon* Pers.
5. *Bothriochlao pertusa* (Wild) A.Cam.

Factors Influencing Outbreaks of *P. oryzæ*

Gopalkrishnan *et al.* (1954) based on their work in South Malabar tentatively inferred that a cloudy and rainy weather in the second fortnight of June followed by a bright and hot weather in the first fortnight of July brings about high incidence.

Hegdekatti (1927) reports that the heavy incidence of *P. oryzæ* is only in years of heavy rainfall especially during the month of May.

Varietal Preferences

It has been observed that the rice varieties show differential responses to the attack of *P. oryzæ*. Work carried out at the Central Rice Research Institute, Cuttack, show that in general, pigmented varieties and scented varieties are less affected by *P. oryzæ*. Green non-scented varieties are found to be more susceptible than green-scented and purple varieties. It is also shown that gall-fly incidence is less in varieties with lower tillering habit than those with higher tillering capacity. Observations carried out by Khan and Murthy (1955) show that the variety H.R. 14 is comparatively less susceptible to gall-fly attack and the purple-pigmented variety H.R. 8 is significantly attacked more than the green-pigmented varieties. This is contrary to the observations recorded at Cuttack. In Bihar, varietal resistance studies to *P. oryzæ* have shown that the varieties *Keshwarpal*, *Dahia*, *Bacha Kalma* are more susceptible and *Gora Neta* and *Bhainsa* are more resistant.

The writer had opportunity to carry out extensive observations in the incidence of gall-fly attack on different varieties in the perennial irrigated zone of Nizamabad district, Andhra Pradesh. It has been observed that in general the long-duration varieties of rice are attacked by the gall-fly more than the short-duration varieties. The following table gives the average numbers of galls produced in a random $3' \times 3'$ unit on three varieties of rice sown at six-weekly intervals.

Date of transplanting	Average numbers of galls in a random 3′×3′ unit in		
	H.R. 19 (early variety)	H.R. 35 (long duration)	R.D.R. 4 (long duration)
28–6–1954 ..	1·07	5·2	3·7
5–7–1954 ..	1·2	5·6	3·5
12–7–1954 ..	2·3	6·3	5·2
19–7–1954 ..	4·6	9·6	5·5
26–7–1954 ..	4·4	7·0	7·7
2–8–1954 ..	5·0	7·5	7·7

The important factor which emerges out of the data is that delay in sowing of the first seasonal crop—especially long-duration varieties results in increase in the incidence of *P. oryzæ*. As already referred to, the short-duration varieties are attacked less than the medium- and long-duration varieties. Amongst the varieties commonly grown in Nizamabad district, the long-duration variety H.R. 35 is found to be very much susceptible (if sown late) to gall-fly attack. Another popular variety *Basangi* is also moderately susceptible.

Incidence in Relation to Time of Sowing

It has been a common observation amongst workers that late sown crops become susceptible to rice gall-midge attack. It is reported that damage is insignificant when operations are carried out early and the plants grow to some height. (*Proc. 3rd Ento. Meeting, Pusa*). Ramachandra Rao (1926) mentions that during 1925, when there was a severe outbreak of this pest in Buntawal in South Kanara, the early planted fields were only lightly attacked, while those planted a fortnight later suffered badly. The earliest possible sowing is recommended by Hegdekatti (1927) as a measure of control against *P. oryzæ*.

Khan and Murthy (1955) have carried out intensive observations in Nizamabad district of Andhra Pradesh and have shown that broadcasting or transplanting of rice crop after the last week of July renders it highly susceptible to gall-fly attack.

Natural Enemies

According to Barnes (1956), three species of chalcids and one braconid keep *P. oryzæ* in check in Siam, parasitisation amounting to nearly 60%. In China, two pupal parasites *Neanastatus cinctiventris* Giri and *Platygaster* Sp., are observed on the rice gall-midge. In India, two chalcidoids and a platygasterid parasite have been noted. In Nizamabad district, *Platygaster oryzæ* C. is the only natural enemy of the rice gall-fly observed. The percentage of parasitisation goes in some cases upto 100%. It is said that in nature the parasites keep *P. oryzæ* in check and that outbreaks of the rice gall-midge could be mainly attributed to the failure of its parasites.

Control

Effective control of *P. oryzæ* is still an unsolved problem. Setting up of light traps is one of the known measures of control, although its efficacy has been doubted sometimes (Barnes, 1956). Khan and Murthy (1955) however state that setting up of light traps is an effective method of control and they have adduced experimental data in this regard. The Plant Protection Organisation of the erstwhile Hyderabad State was advocating this measure along with advice on the timely sowing of the first crop of paddy. Sen (1953) in Bihar has also found this method effective.

Barnes (1956) suggests the flooding of paddy fields at the time of emergence of *P. oryzæ* in order to prevent successful oviposition on the plants. But in view of Patel and Bhatt's (1954) statement that *P. oryzæ* could oviposit on standing water it is to be seen whether this method would be effective.

Application of quick acting fertilisers has also been suggested. This would help the plant in producing new tillers to compensate in cases of mild infestation.

Insecticidal control of *P. oryzæ* is of recent origin. Patel and Bhatt (1954) have tried the following chemicals as spreading agents over water in the paddy field and have found them fairly effective against gall-fly.

1. Mineral oil 10 lb./acre saturated with dieldrin.
2. Parathion 1·6 lb./acre and
3. Water-dispersible chlordane 8 lb./acre.

Reports from Bihar state that different insecticidal treatments tried during paddy season when the infestation of *P. oryzæ* had spread, did not produce appreciable effect in minimising the infestation. The

writer has also experienced that insecticidal treatments against rice gall-fly bristles with practical difficulties as the emergence of adult midges is not uniform and secondly the prevailing S.-W. monsoon rains during the first crop season renders insecticidal treatments ineffective in most of the cases.

A suggestion is made that instead of application of insecticides after the crop has been transplanted, efforts be made to apply them to the first crop nurseries sown generally during the month of May. At this time, the incidence of *P. oryzæ* would be a very low level and the S.-W. monsoon rains would not have set in.

Summary

A brief review of published literature on the rice gall-midge *Pachydiplosis oryzæ* (W.M.) Mani with particular reference to the Indian Union is presented in the paper.

Acknowledgements

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A SYSTEM OF APIARY MANAGEMENT FOR SUCCESSFUL BEE-KEEPING

By B. M. Muthapa[1]

Evolution of a proper system of apiary management is the foundation of success in bee-keeping. India being a vast country cannot have one standard or one set of hives and appliances, nor the system of apiary management can be the same for all India. Each locality or zone has a problem of its own, peculiar to itself, and hence the bee-keeper should so shape his seasonal operations and cultural practices as to employ his bees to gain his object, namely, reaping the maximum honey crop with least possible labour.

It should always be borne in mind that it is the bee that gathers the honey, and not the man. So, the bee-keeper should aim at replacing his (man) labour with bee labour. His business is to co-operate with and guide the bee by knowing its secrets at every stage of its development.

To get the surplus honey in good quantities, the outlook of the bee colony, the natural instinct of which is to store some honey and then to swarm, must be transformed to one of continuing to store and not to swarm. To accomplish this, the usual brood rearing compartment must be large enough for the queen to lay as many eggs as are needed to build up colony strength at the right time and to the required level.

Under favourable condition and under proper management *Apis mellifera indica* is capable of giving us good records of yield. Our 18 years of work with it has shown that it merits further study and work for further improving it.

The essential factors for getting a good yield are the following:

1. Sufficient Bee Population to work at the Honey Flow

The colonies must be so worked as to make them capable of putting up maximum strength numerically at the time when honey flow is at its peak. Some colonies, even though they are numerically strong, don't put maximum efforts at gathering honey. Frequent extractions of honey must be made from such colonies, thus bringing them to the starvation point to induce them to put hard work at the honey flow.

A weak colony must not be tolerated in any apiary. It is just like a sick man in the house. It should be either brought up to honey storing

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strength or got united with another. It is a head-ache to retain a weak colony as such.

(*a*) *Required Colony Strength for Storing Honey.*—To ensure this there should be a young prolific queen, workers of foragable age, steady and non-stop brood rearing in the hive. The morale of the colony must be directed to honey storing.

To accomplish this, every colony should be re-queened at the beginning of the swarming season. Every bee-keeper knows that the worker bee takes three weeks for its emergence and another three weeks to be ready to go to the field. Supposing the bee-keeper wants a large force of field bees about the first week of April, he must stimulate the queen to lay heavily during the second week of February. The queen must be kept in good humour to continue with her non-stop laying by our not creating congestion in the brood chamber and by providing her with sufficient laying space. As the bees go on storing ceaselessly, the bee-keeper should go on aiding them in advance of time by providing them with storing space, ventilation, water, shade, etc.

(*b*) *Amongst the above factors may also be mentioned the following as contributory factors.*—(1) Personality of the bee-keeper, (2) the system of apiary management that he uses; (3) weather conditions; (4) locality condition in relation to its nectar flow; (5) duration of the honey flow and its intensity. For the success of bee-keeping the bee-keeper himself is the pivot. If he is well-versed with the habits of bees, the bees' psychology and everything about them, and with proper type of management, favourable weather conditions, suitability of the locality with the duration of nectar flow being sufficiently long and its intensity heavy, he can expect to come out fully successful.

(*c*) *Care of Bees during the Off-season.*—The care of bees during the off-season is as much important as it is during the honey flow. Unless the bee-keeper looks after the health of his bees throughout, he cannot expect to work miracles by attending on them during the honey flow only. (1) Disturbance in the colony by injudicious work with it, by an uncomfortable hive or by any surroundings which tend to break the normal routine of bees, thereby encouraging swarming impulse, will also affect the honey crop. (2) Providing favourable conditions and aiding them to conserve energy during the rainy season in places where it is severe and also during early brood rearing in winter, will keep the bees in good spirits for the rest of their period of activity. When brood rearing period begins, consumption of stores is greatly increased and as such, many colonies are in danger of running short of stores at this time. As the bee-keeper is expected to know that a frame full of honey and a good quality of pollen are required to rear up a frame full of brood, sufficient

stores must be provided in time not to cripple the progress of his colonies.

Sometimes there is starvation amidst plenty. You sometimes find dead bees on the floor board even when there are sufficient stores and when honey is in crystalline form or is heavy. Being unable to get water in sufficient quantities to dilute it, starvation deaths take place. In such cases feeding them with water or thin sugar syrup will relieve the starvation.

Apiary location, well-protected against cold wind and breeze, is very important in all places of heavy rainfall.

(*d*) *Importance of Good Combs.*—The importance of perfect combs in the brood chamber should not be underestimated. They discard old and imperfect combs as unsuitable for brood rearing. If the queen does not lay properly in the top portions of the empty comb, one can be pretty certain the comb is faulty. Moreover, poor, brace and burr combs increase the trouble of swarming greatly. There is possibility of wax moth attack on old combs. Hence all poor combs should be melted to wax yearly.

2. Location of the Apiary

Location of the apiary in a place where there is plenty of bee pasture is as important as the knowledge of bees and bee-keeping. A high lying valley with thick vegetative growth all round, sloping east or north-east or south-east is considered to be an ideal site. By ensuring large range of site for the bees, the bee-keeper is making bees travel over long distances for collecting honey from far and wide.

3. Starting Work in the Supers Right from the Beginning of the Honey Flow

Bee should have completed all nature of work in the brood chamber and come up to the super promptly by the time the honey flow sets in. Drawn combs in the super will accelerate progress of work of bees to a considerable extent. There should be proper bee space between every comb and at every point. By this the activities of bees go on unchecked.

4. Free and Easy Movement of Bees in Supers and the Brood Chamber

The work of bees should not be interrupted because of congestion in the brood chamber and the super and hence the bee-keeper should see that there is clean passage for bees all round the comb and at every point. If the combs are perfect ones with all worker cells, the bees take pleasure to work on them.

5. Continuous Replacement of Bees that Die Out

Every bee-keeper knows that bees die out after a short while of life activities. So, he should so manipulate his colony as to see that there is continuous brood rearing to replace the ones that die out. He should see that he re-queens his colony every year.

6. Conditions of the Colony at the End of the Honey Flow Season

As honey flow season comes to a close the queen foresees that there is a bad time ahead of her and slows down the rate of her egg laying. The spirit of the hive decides that there should be no brood rearing at that rate when the resultant bees are no longer required for honey production. Moreover, brood rearing means expenditure of stores and the bees feel that they cannot afford that expenditure at that time. The bee-keeper should prepare his bees for the fall by providing for their necessities and comforts. The bee-keeper should also see that supers uncovered by the bees are removed and stacked after fumigation in a moth-proof way. The weak colonies should be united lest they should perish during the fall. He should also see that the colonies have sufficient stores to wade through the difficult times.

Six important factors for successful bee-keeping have been discussed on broad lines in this paper. Many more details remain to be filled in to make it even nearly complete. The method of operation varies greatly from locality to locality and certain modifications are called for in certain places under certain conditions.

There is no winter problem as such in Coorg. But we do have severe monsoon problems. As such the points discussed in this paper are mostly in relation to conditions obtaining in Coorg.

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SOME INSECT PREDATORS OF APHIDS (APHIDIDAE) IN MYSORE

By M. Puttarudriah and G. P. Channa Basavanna[1]

Aphids or plant lice are a group of phytophagous sucking insects very commonly found on various crops and some of them are often highly destructive, like the pea aphid, the tobacco aphid, the cabbage aphid and the groundnut aphid. Almost every species of aphids is preyed upon by certain insects and some fungi. Sometimes these natural enemies no doubt form a valuable check over the multiplication of aphids. In most cases, these parasites and predators appear only in sufficient numbers to control the aphids when they have increased to such an extent that the affected crop has been seriously damaged or even destroyed, more especially so in the short-lived crops than in the perennial ones.

The chief groups of predators of plant lice are the lady-bird beetles (Coccinellidæ), the flower flies (Syrphidæ) and the aphid lions (Chrysopidæ and Hemerobiidæ). Apart from these groups the maggots of the small flies (Chamæmyiidæ), certain bugs and a lepidopterous caterpillar are also noted to feed upon the aphids but are rarely important in controlling the pest. Amongst the predaceous groups the lady-bird beetles are, as a rule, by far the most numerous both in respect of aphidiphagous species and also often in numbers of individual species. The beetles either suck the body-juice of aphids or devour them entire, and they also feed likewise in their larval stages. Flower flies or hover flies drop their eggs among colonies of aphids and these eggs hatch into leach-like maggots which avidly suck the body-juice of aphids. Sometimes they are quite effective in keeping aphid infestations under check. The aphid lions are small and alligator-like and are voracious feeders on the young ones and adults of aphids. Some of these even camouflage their bodies by covering them with cast skins, etc., of the aphids.

It is proposed to make a list of insect predators of aphids as a step to further studies on their biology and on the possibilities of utilising any of them in the biological control of aphid pests. The present list is just a beginning and is to be followed up by further additions. There appears to be no comprehensive list of predators of aphids present in India, excepting scattered records of predators mainly in the biological accounts of certain individual species of aphids. The predators are listed in the alphabetical order under each order and family. together with the information on the place in and the season during which they were found.

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Predator	Prey	Place and season	Remarks
	COLEOPTERA : COCCINELLIDÆ		
1 *Anisolemnia dilatata* (Fabr.)	*Oregma bambusæ* Buckt. on bamboo leaves	Bangalore : June–July	Occasional
2 *Brumus suturalis* Fabr.	*Aphis nerii* Fonsc. on *calotropis*	Bangalore : May	Rare
3 *Coccinella arcuata* Fabr.	*Geoica* sp. ? *lucifuga* Zehnt. on potato roots	Bangalore : August	do.
4 *C. arcuata* Fabr. *octomaculata* Fabr.	(1) *Macrosiphoniella pisi* Kalt. on pea (2) *Aphis rumicis* L. on cowpea	Bangalore : August	do.
5 *C. 8-maculata* Fabr.	*Macrosiphoniella pisi* on pea	Bangalore : May	do.
6 *C. repanda* Thunb. ab. *transversalis* Fabr.	(1) *Aphis craccivora* Koch. on groundnut (2) *Therioaphis ononides* Kalt. on lucerne	Davangere : July Bangalore : June	Common Very common
7 *C. septumpunctata* L.	(1) *Rhopalosiphum pseudobrassicæ* (Davis) on mustard (2) *Therioaphis ononides* on lucerne, and other species of aphids also	Bangalore : July–August	Very common and abundant
8 *Cælophora Bissellata* Muls. ab. *nudipennis* Sic.	(1) *Aphis gossypii* Glov. on cotton (2) *Aphis craccivora* on groundnut	Bangalore : July Davangere : July	Rare do.
9 *Hyperaspis maindroni* Sic.	*Aphis gossypii* on cotton	Bangalore : October	do.
10 *H. m. brumoides* Sic.	do.	do.	do.
11 *Menochilus 6-maculatus* (Fabr.) [= *Chilomenes sexmaculatus* (Febr.)]	(1) *Aphis craccivora* on groundnut (2) *Aphis rumicis* L. on cowpea (3) *Aphis sacchari* Zehnt. on jola (4) *Aphis nerii* on *Calotropis.* and other species	Throughout the State. All the seasons	Very common
12 *M. 4-plagiatus* Swartz var.	*Aphis gossypii* on guava	Bangalore : October	Rare
13 *Micraspis cardoni* (Wse.)	Aphids on *Gliricidia*	Bangalore : April–May	do.
14 *Nephus regularis*, Sic.	*Aphis gossypii* on cotton	Bangalore : April	do.

Predator	Prey	Place and season	Remarks
15 *Propylea 14-punctata* (L.)	*Macrosiphoniella pisi* on pea	Bangalore : August	Rare
16 *Pseudaspidimerus circumplexa* (Mots.) var. *testaceus* Wse.	(1) *Aphis craccivora* on groundnut (2) *Aphis gossypii* on guava (3) *Aphis rumicis* on cowpea (4) *Aphis malvoides* on potato and a number of others.	Bangalore : Almost throughout the year	Common
17 *Pullus castaneus* Sic.	(1) *Aphis maidis* Fitch on Ragi (2) *Aphis malvoides* on potato (3) *Aphis nerii* on *Calotropis*	Chickballapur: May Bangalore : Feb.–May	do.
18 *Pullus* sp. ? *guimeti* Muls.	(1) *Aphis gossypii* on cotton (2) *Aphis malvoides* on potato (3) *Aphis nerii* on *Calotropis*	Bangalore : Feb.–May	do.
19 *Pullus nubilus* Muls.	(1) *Aphis craccivora* on groundnut (2) *Rhopalosiphum nymphæ* on Trapa (3) *Aphis nerii* on *Calotropis* and several others	Bangalore : Jan.–April	do.
20 *Pullus picescens* Gorh.	*Rhopalosiphum nymphæ* (L.) on Trapa	do.	Occasional
21 *Pullus* sp.	*Aphis gossypii* on cotton	Bangalore : July	do.
22 *Pullus victoris* Mots.	*Aphis nerii* on *Calotropis*	Bangalore : April	do.
23 *Pullus xerampelinus* Muls.	(1) *Aphis craccivora* on groundnut (2) *Aphis nerii* on *calotropis* (3) *Aphis gossypii* on cotton	Davangere : July Bangalore : April–May	Common do
24 *Scymnus (Pullus) quadrillum* Mots.	(1) *Aphis gossypii* on cotton (2) *Aphis rumicis* on cowpea	Bangalore : July	do.
25 *Synonycha grandis* Thumb.	*Oregma bombusicola* Takahashi on bamboo shoots	Bangalore : Almost throughout the year	do.
	COLEOPTERA : DERMESTIDÆ		
26 *Aspectus indicus* Arrow	*Aphis nerii* on *Calotropis*	Bangalore : April	Rare; exact role not known
27 *Orphinus minor* Arrow	do.	do.	do.

Predator	Prey	Place and season	Remarks
	DIPTERA : SYRPHIDÆ		
28 *Syrphus balteatus* Deg.	*Myzus persicæ* Sulza. on Cabbage	Bangalore : April–June	Common
29 *Xanthogramma (Ischiodon) scutellare* (F.)	*Aphis craccivora* on groundnut	Davangere : July–Aug.	do.
	DIPTERA CHAMÆMYIIDÆ (=OCHTHIPHILIDÆ)		
30 *Leucopis* (=*Neoleucopis*) *luteicornis* Mall.	*Aphis gossypii* on cotton	Bangalore : April	Very common
31 *Leucopis puncticornis* (Meig.)	*Aphis rumicis* on cowpea	Bangalore : February	do.
	NEUROPTERA : CHRYSOPIDÆ		
32 *Chrysopa* sp.	*Aphis rumicis* on cowpea and other species of aphids	Bangalore : October	Common
	NEUROPTERA : HEMEROBIIDÆ		
33 *Eumicromus* sp.	*Aphis nerii* on *Calotropis* and other species	Bangalore : September	do.
	HEMIPTERA : LYGÆIDÆ		
34 *Geocoris* sp.	(1) *Aphis nerii* on *Calotropis* (2) *Aphis gossypii* on cotton	Bangalore : April	Rare
	LEPIDOPTERA : AGROTIDÆ		
35 *Eublemma scitula* Ramb.	*Oregma bambusicola* Takahashi on bamboo shoots	Bangalore : November	do.

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PARTHENOCARPY IN SOME FRUIT PLANTS

Part II.[1] Review of Literature on Parthenocarpy Induced by Growth Substances and Its Effects on Fruits and Plants

By N. N. Dikshit[2]

In an earlier publication the author reviewed parthenocarpy as it occurs in nature, and that induced by agents other than growth substances. The present review, second in the series, includes literature on parthenocarpy as induced by growth substances, and its effects on fruits and plants.

In preparing this article, the author has obtained a good deal of help from earlier reviews by Gustafson (1942) and Pearse (1948). It differs from the first in that some of the older references have been deleted to include more recent work, and from the second in being more exhaustive on the subject of parthenocarpy. Mitchell and Marth (1950) and Van Overbeck (1952) have reviewed the scope of growth harmones in horticulture.

The following aspects have been included:—

(*a*) Chemicals reported to induce parthenocarpy.

(*b*) Methods of application of growth substances.

(*c*) Results obtained with different plants.

(*d*) The effects on fruits and plants.

The last section has been further split into four subsections, *viz.*, (i) Chemical, (ii) Nutritional, (iii) Morphological and lastly (iv) Histological differences induced due to occurrence of parthenocarpy.

(*a*) *Chemicals*

The results obtained by application of some of the chemicals which are known as growth regulators have been very promising and at times even spectacular. These include some indole compounds: acetic, butyric and propionic acids, some naphthoxy compounds: beta-naphthoxy acetic acid, beta-naphthoxy propionic acid, some naphthalene compounds: naphthalene acetic, butyric and propionic acids; and some derivatives of phenoxy acids: 2, 4-dichlorophenoxy acetic acid and 2, 4, 5-T, etc. Besides these some other chemicals such as acenaphthane, œstrone sul-

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[2] *Plant Physiologist*, Citrus Dieback Scheme, Gonikoppal, Coorg.

phanilamide phenyl acetic acid and skalatol are others which have induced physiological responses. It has been observed that the chemical structures which impart physiological activity to the compound are of diverse structure and there is no grouping or structural feature common to them all. The preceding list does not include all the physiologically active compounds nor it is meant to be exhaustive. An attempt has been made to give a list of most frequently used compounds.

(*b*) *Methods of Application*

(*i*) *In Lanolin Paste.*—Since the growth substances readily dissolve in molten lanolin paste, it has been a convenient medium for applying the growth substances. Its use, however, is restricted to cases where the number of flowers to be treated is small. Extra care should be taken to restrict the application of hormone in lanolin paste to the desired spot only, as the results are likely to be unfavourable if an unduly large area of ovary is smeared with the preparation. Good response was induced by using hormone in lanolin paste by HOWLETT (1939), STRONG (1941) AND HILTON (1944), on a large number of plants. It has been recommended that for finer work, lanolin should be purified to get uniform results (REDEMAN, WITTWER AND SELL, 1950).

(*ii*) *Spraying.*—Growth substances can be dissolved in water or prepared in emulsion form for spraying. This mode of application has been found to be very suitable for glass-house spraying of tomatoes to promote fruit-set [ZIMMERMANN AND HITCHCOCK (1941), HOWLETT (1941, 1945), SWARBRICK (1942, 1945) AND ROBERT AND STRUCKMEYER (1944)].

(*iii*) *Aerosol.*—It has been found to be convenient as well as effective to apply the growth substances after dissolving them in liquefied gases. When such a solution is released through a fine nozzle the gas leaves dissolved growth substance in finely suspended form. The method was found to be useful for green-houses [HAMMER, SHOMER AND GOODHUE (1944) AND HAMNER, SHOMER AND MARTH (1944)].

(*iv*) *Vapour Method.*—Yet another method of applying growth substance to green-house crops is to evaporate it on a hot plate. The quantity of the chemical to be used should be determined with great caution as overdoses are likely to induce undesirable effects on the plants [ZIMMERMANN AND HITCHCOCK (1939) AND STRONG (1944)].

(*v*) *In Carbowax.*—The growth substances can be dissolved in carbowax and stored. The desired dilutions can be prepared at the spot by dissolving the carbowax tablet in requisite quantity of water. This eliminates the need for transporting the chemicals in solution form.

(c) Results Obtained with Different Plants

(i) Tomato.—HERBST (1939) produced seedless tomatoes by spraying of indole butyric acid as solution or in lanolin paste. GUSTAFSON (1940) induced fruit-set in John Baer variety of tomatoes and observed no difference in the extent of fruit-set. The seedless fruits tended to be smaller than the seeded if the soil was not very rich. HOWLETT (1939) applied indole acetic acid, indole butyric acid, and potassium naphthalene acetate in lanolin paste and obtained seedless fruits to varying extents. The same worker (1941) tried indole butyric acid, indole acetic acid, naphthalene acetic acid, methyl indole butyrate, aplha naphthylthio acetamide and potassium naphthalene acetate and obtained 90–100 per cent. fruit-set under favourable conditions. The chemicals were applied in lanolin paste and as lanolin emulsion. The parthenocarpic fruits were bigger than the normal seeded ones when indole butyric acid was used. JANES (1941–42) produced seedless fruits by using indole acetic acid and indole butyric acid. MITCHELL AND WHITEHEAD (1942) got high percentage of seedless fruits by applying beta naphthoxy acetic acid in vapour form under green-house condition. GUSTAFSON obtained seedless fruits in five varieties of tomatoes with beta naphthoxy acetic acid. The fruits were larger than the normal seeded ones. HILTON (1944) applied indole butyric acid and naphthalene acetic acid as spray and in lanolin paste to stigmas, flower bases, flower cluster bases and to ovary bases when the styles were removed. He got 53 per cent. succes with lanolin paste. SWARBRICK (1944) failed to get seedless fruits with alpha naphthalene acetic acid, but sprays with 30 ppm. beta naphthoxy acetic acid and 1 ppm. 2, 4-dichlorophenoxy acetic acid, when given to the emasculated flowers were effective. The same author (1945) observed parthenocarpic development following sprays with 50–100 ppm. Stilboesterol (4-4-dihydroxydiethyl stilbene) and Henosterol. HOWLETT (1945) induced fruit-set by application of 2 per cent. butyric acid sprays, in cloudy weather, when conditions for pollination are not favourable under green-house culture of tomatoes. KEMP (1946) obtained increased set by spraying blossoms with 100 ppm. beta naphthoxy acetic acid, 50 p.p.m. 2, 4, 5-trichlorophenoxy acetic acid or 10 p.p.m. 2, 4-dichlorophenoxy acetic acid. STRONG (1946) obtained positive results by using 10 p.p.m. 2, 4-D. SWARBRICK (1945) and VAN KOOT (1947) have separately discussed the possibilities of the use of chemicals in commercial production of green-house tomatoes. MANN AND MINGES (1949) induced increased production seedless fruits under field conditions by using beta naphthoxy acetic acid, 2, 4-D, and 4-chlorophenoxy acetic acid. HITCHENS (1950) induced rogues of tomatoes called Jacks, to produce well-shaped fruits by systematic spraying with growth chemicals. BENTLEY AND BICKLE ( ) obtained parthenocarpic fruits by applica-

tion of 3-indole-acetonitrole, which they prepared by concentrating from natural sources. ZALIK, HOBBS AND LEOPOLD (1951) produced parthenocarpic tomatoes by application of parachlorophenoxy acetic acid, in lanolin paste. ORDONO (1951) got positive results by application of naphthoxy acetic acid. SINGH AND KAKKAR (1952) induced parthenocarpy by use of indole acetic acid in lanolin paste or as dry injection to the trunks. HERMANN (1953) reported improved set and better quality by use of commercial hormone products. Similar positive results were obtained by JOHNSON AND HALE (1953) using parachlorophenoxy acetic acid; LEOPOLD, GUERSNEY AND LANGSTON with acetic acid mixed with pantothenic acid; PARSON AND DAVIS (1953) with parachlorophenoxy acetic acid and SEBANEK (1953) with tri-iodo-benzoic acid. Others who have reported similar results with a number of growth substances are PULLIN AND RUSSO (1951); OSBORNE, WAIN AND WALKER (1952) and OSBORNE AND WENT (1953).

(*ii*) *Cucurbits.*—WONG (1938), working with water melons, obtained seedless fruits by application of alpha naphthalene acetic acid in lanolin paste. The lowest concentration used (2·5 per cent.) gave the highest result. The author further observed (1939) that better results could be obtained when alpha naphthalene acetic acid was used with acenaphthene. The author also reported that (1941) indole butyric acid 1–5 per cent., acenaphthane 10 per cent. and sulphanilamide 1·5 per cent. were ineffective in inducing parthenocarpy, when applied in form of lanolin paste. OINUE (1938) produced seedless fruits of water melons by applying growth substances. SEREISKY (1939) applied heterauxin in lanolin paste and reported induction of growth of seedless fruits in *Cucurbita pepo* L., *Citrulus edulis* Pang., and *Luffa cylindrica*. GUSTAFSON (1936, 1941) induced development of parthenocarpic fruit in cucumber, squash and tomatoes with naphthalene acetic acid. Indole butyric acid was also successful. Indole acetic acid was not so effective while 4-fluorin acetic acid was ineffective. HUBERT AND MATON (1939) succeeded in getting seedless fruits in *C. pepo.* by application of naphthalene acetic acid in lanolin paste. TRECCANI (1948) induced seedless fruits in marrow and water melons by spraying 10 p.p.m. 2, 4-D. LIU AND CHERNG (1948) induced parthenocarpy in some cucurbitaceous plants with 1 per cent. fluorescence in lanolin paste. CAPININ AND NATIVIDAD (1951) obtained fruits with reduced number of seeds following 2, 4-D sprays. NEUMANN (1952) induced formation of seedless fruits in oil pumpkin with the help of alpha naphthalene acetic acid.

(*iii*) *Other Plants.*—FUNKE (1938) induced coiling of the stalk of female flowers of *Vallisnaria spiralis*, and occurrence of parthenocarpy by using alpha naphthalene acetic acid, beta indole acetic acid when used in 3 p.p.m. concentration. HUBERT AND MATON (1939) during their

studies on the influence of growth chemicals on post-floral phenomenon in the tropical orchids found naphthalene acetic acid to be most effective in inducing parthenocarpy. JANES (1942) produced parthenocarpic fruits of pepper and compared them with normal seeded fruits. WILLIAMS (1943) induced heavy setting of flower-buds in some species of Ilex, when cuttings were treated with indole butyric acid. CABELLERO (1947) produced parthenocarpic fruits in *Sternbergia lutea* when the growth chemicals were applied as volatile preparation or as lanolin paste. VILLARIBA AND CAPININ (1948) reported best results in inducing seedless fruits in egg plants with 25 p.p.m., 2, 4-dichlorophenoxy acetic acid. BRITTEN (1947, 1950) studied several methods of application of growth substances to maize cobs. RANJAN AND KAUR (1951) reported parthenocarpy in *Hibiscus esculenta* and *Solanum melongena.*

(*iv*) *Fruit Trees:* (*a*) *Apples.*—HILTON (1944) observed no clear-cut case of parthenocarpy when 3293 plants were sprayed with growth substance at full bloom. LUCKWILL (1946) isolated a hormone-like substance from developing seeds of apple, and this substance was effective in inducing parthenocarpy in tomatoes. OSBORNE AND WAIN (1951) obtained preliminary success in inducing parthenocarpy in apple by application of alpha-phenoxy propionic acid as spray in 100 p.p.m. concentration.

(*b*) AVOCADO, STEWART AND HIELD (1951) tried triethanolamine salt and isopropyl ester of 2, 4-D, and butyl ester of 2, 4, 5-T in various concentrations. Parthenocarpy was induced by using 2, 4-D spray in April.

(*c*) *Banana.*—SIMMONDS (1953) induced parthenocarpy in normal seeded forms of banana by application of alpha naphthyl acetic acid.

(*d*) *Fig.*—CRANE AND BLONDEAU (1949) tried to produce parthenocarpic figs by using 25 p.p.m. 2, 4, 5-trichlorophenoxy acetic acid on unpollinated syconia, and obtained fruits which though devoid of achenes were normal in size, sugar and colour. The same authors later (1950) obtained encouraging results with parachlorophenoxy acetic acid. BLONDEAU AND CRANE (1950) tried a number of growth substances and found indole butyric acid, naphthalene acetic acid and 2, 4, 5-trichlorophenoxy acetic acid to be most effective. Parachlorophenoxy acetic acid was most encouraging because of lack of toxicity, low concentration needed and the comparative low cost of the chemical. CRANE AND BASKAYA (1950) produced parthenocarpic figs using parachlorophenoxy acetic acid and gamma indole 3-*n*-butyric acid. HARRIS (1950) does not consider the use of chlorophenoxy acetic acid and beta indole butyric acid to be of practical value at present. CRANE (1952) observed growth regulator specificity in the development of ovary wall in

parthenocarpic figs. Spina (1952) produced seedless figs by using indole butyric acid and 2, 4-dichlorophenoxy acetic acid.

(*e*) *Fuhukaki.*—Asami (1941) obtained parthenocarpic fruits by using naphthalene acetic acid sprays, where 0·05 per cent. solution gave 84 per cent. seedless fruits and 0·005 per cent. solution induced only 3 per cent. seedless fruits. Methyl indole acetic acid induced intermediate results.

(*f*) *Holly.*—Gardner and Marth (1937) sprayed open flowers and buds with indole acetic acid and naphthalene acetic acid solutions. Both the chemicals induced parthenocarpy and the latter was found to be more effective. In New Jersey (1951–52) holly produced parthenocarpic fruits by application of 25 p.p.m. 2, 4-dichlorophenoxy acetic acid.

(*g*) *Orange.*—Wong (1939) could not produce parthenocarpic fruits in hamlin orange although the variety bears seedless fruits naturally; indole acetic and butyric acids were used in 0·5 and 1·0 per cent. concentrations.

(*h*) *Papaya.*—Villariba and Capinin (1948) induced parthenocarpy in papaya by using 2, 4-dichlorophenoxy acetic acid. Ordono (1951) reports positive results with indole butyric acid and naphthalene acetic acids when applied in lanolin paste.

(*i*) *Pears.*—Sereisky (1938) induced seedless fruits in pears by indole acetic acid. Lewis (1946) studied the action of naphthalene acetamide on the process leading to fruit development in a number of species including *Pyrus communis* (Pears) and concluded that parthenocarpy can be induced in many seeded fruits only, by application of growth substances. Osborne (1949) sprayed emasculated flowers of Pitmaston Dutchess pears with alpha-2-naphthoxy propionic acid and produced seedless fruits which were normal in appearance. The parthenocarpic fruits induced in another variety Dr. Jules Guyot were somewhat smaller than the normal fruits. Wain (1950) obtained 100 per cent. set of seedless fruits by spraying emasculated flowers of two varieties, *viz.*, Pitmaston-Dutchess and Dr. Jules Guyot, with 100 p.p.m. solution of alpha-(2-naphthoxy)-propionic acid. Osborne and Wain (1951) obtained parthenocarpic fruits in some varieties of pears by application of growth substances. Batjer and Uota (1951) found that the seed content of Bartlett pears was affected in an orchard which was not cross-pollinated, following sprays with 2, 4, 5-trichlorophenoxy acetic acid. Griggs, Ben, Iwakiri and De Tar (1951) found higher percentage of seedless fruits in pears after sprays with 2, 4, 5-T at full bloom.

(*j*) *Pine apple.*—Clark and Kerns (1942) studied the effect of growth substances on fruits.

(*h*) *Strawberries.*—Hunter (1941) sprayed flowers of strawberries with solutions of indole butyric acid, naphthalene acetic acid, colchicine and acenaphthane powder. Parthenocarpic fruits were produced even in flowers that were not treated directly. Wong (1941) and Swarbrick (1943) also produced seedless fruits with the help of growth substances.

(*i*) *Grapes.*—Oinoue (1938) induced development of seedless fruits in grapes by application of heterauxin 0·05 per cent. of lanolin paste to emasculated flowers. Muller Stole (1950) induced small parthenocarpic berries to grow by repeated sprayings with 0·05 and 1 per cent. heterauxin. Coombe (1950) produced seedless berries by application of parachlorophenoxy acetic acid at 50 p.p.m. in currents. Further, encouraging results were obtained by spraying with tri-iodo-benzoic acid, at La Hulpe Research Station. However Caroline (1950) could not induce parthenocarpy in Barbera and Harslevelu varieties of vines by using various concentrations of beta naphthoxy acetic acid.

(*d*) *Causes of Parthenocarpy and its Effects on Fruits and Plants.*

Seedlessness of fruits is associated with a number of diverse causes which are enumerated below:

(*a*) Defective embryo sac formation is the cause of seedlessness in black corinth grapes [Pearson (1933)].

(*b*) Destruction of pollen due to insects or adverse environmental conditions:

(i) Destruction of pollen due to insects induced development of seedless fruits [Hummel (1920)].

(ii) Campbell (1912) observed development of seedless fruits in olive after incidence of frost. Chiarugi (1930) observed similar thing in *Ziziphus sativa*; Cochran (1936) noted that the number of seedless fruits in capsicum was more if the plants were raised at 50–60° F. at the time of anthesis. Hawthorn (1937) observed that a hybrid tomato plant produced seeded fruits in June and early July, seedless fruits during hot summer months and again seeded fruits during fall. Similarly the English forcing cucumber is reported to produce seedless fruits when grown at high temperatures and seeded fruits when grown at low temperature at John Innes Horticultural Institute.

(iii) There is a fairly prevalent belief that the pollen not only supply the chromosome content at the time of fusion of gametes but they also carry some chemicals which possess catalytical or hormonal properties. The belief is strengthened by the fact that Millardet (1901), Savelli (1927), Yasuda (1927), Gustafson (1937) and Swarbrick (1945) successfully induced parthenocarpy by using foreign pollen, or pollen

extracts. Besides, LUCKWILL (1946) extracted a substance of hormone nature from developing apple seeds which was capable of inducing parthenocarpic development of fruits in some plants.

(iv) It has been observed that hormone content of ovaries of habitually parthenocarpic varieties is higher than the content of habitually seeded varieties.

(*c*) During interspecific crosses some F_1 plants are produced which tend to bear seedless fruits:

(i) HEILBORN (1922) observed that in *Carica pentagona* an aberrant type of reduction division took place, resulting in development of seedless fruits.

(ii) CASTETTER (1930) obtained plants producing seedless fruits from interspecific crosses of cucumber.

(iii) It was observed at John Innes Institute (1940) that when *Prunus cerasifera* variety Red (2X) was pollinated with *Prunus domestica* (6 X) seedless fruits are produced which ripen earlier.

(*d*) GROFF (1930) suspected that parthenocarpy in some varieties of pumelo was due to seed abortion. He observed shrivelled and scarcely noticeably seeds in some mature fruits.

(*e*) GUSTAFSON (1930), during his fairly extensive study on parthenocarpy has been able to show the presence of growth substances in young developing fruits. He also observed that ovules, seeds and tissues surrounding them were the richest in growth substances.

(*e*) *Effects of Parthenocarpy*

The seedless fruits have been observed to differ from the normal seeded ones in setting, shape and size, maturity, chemical composition and histological details. Further, the normal seeded fruits and parthenocarpic fruits exert a profound effect on the other parts of the parent plant.

(*i*) *Fruit Size and Shape.*—WONG (1940) during his studies on parthenocarpy in horticultural crops observed that seedless fruits of normal size could be produced with growth substances, without objectionable seed coat in some plants and varieties. GUSTAFSON (1940) showed that seedless fruits tended to be smaller in size than the normal seeded ones. BEAL (1943) observed that the seedless fruits developed like normal fruits and attained the same size in final stage. In some cases the seedless fruits become dark in colour and dry after some initial development. LUCKWILL pointed out that tomato fruits induced by action of 2, 4-dichlorophenoxy acetic acid were irregular in shape; on the other hand, the fruits induced by the action of beta naphthoxy acetic

acid were of normal shape. CRANE AND BLONDEAU (1949) observed that the parthenocarpic figs were normal in shape and colour. JANES (1941) observed that tomato fruits induced by the use of indolyl acetic acid and those induced by action of indolyl butyric acid were smaller than the normal fruits. HOWLETT (1939) working on tomato observed that if the weight of normal seeded fruit is taken as 100, that of indolyl acetic acid induced will be 66, and indolyl butyric acid induced fruit will be 129. BIEDERMANN (1951) suggested that deformity in some pears may be due to parthenocarpy.

(*ii*) *Fruit Setting*.—HOWLETT (1939) observed that the percentage of fruit-set varied with the concentration of indolyl acetic acid, and indolyl butyric acid. Using 0·02, 0·1 and 0·5 per cent. indolyl acetic acid he obtained 36, 48 and 64 per cent. set respectively. The highest setting was observed in the control (78·6 per cent.). GUSTAFSON (1942) on the other hand asserted that the setting in treated fruits could be at least as high as in the normally pollinated flowers. He also found that the early rate of growth was faster in the treated fruits. This rate however slowed down at a later stage. GRIGGS (1951) observed that following sprays with growth substances all the flowers in a cluster started developing as against 1–3 per cluster in the control.

(*iii*) *Maturity*.—SAUL, HOBBS AND LEOPOLD (1951) observed that parthenocarpic fruits matured earlier than the normal seeded ones.

(*iv*) *Chemical Composition*.—CONDIT found that the seedless fruits of DIOSPYROS KAKI were light coloured and astringent until quite soft and ripe. But the seeded fruits were non-astringent even when hard. The same author further observed (1920), that uncaprified figs had higher sugar content than the caprified ones. JANES (1941) showed that in tomato, total titrable acidity was similar in seeded and seedless fruits, but the distribution of acids differed. In the seeded fruits it was more concentrated towards the seeds, and less towards the periphery. On the other hand, the seedless fruits showed a more or less uniform distribution of the acid throughout the fruit. The seedless fruits tended to be richer in starch and sugar content. The same worker observed that in pepper the parthenocarpic fruits were superior in dry weight, soluble solids and total sugars. POLLARD, MARGARET AND STEEDMAN (1945) found that parthenocarpic fruits had a sweeter flavour and slightly more sugar. No significant difference was observed in titrable acids or total solids. LUCKWILL (1946) found that the tomato fiuits induced with the help of beta naphthoxy acetic acid, tended to be slightly richer in sugar. CRANE AND BLONDEAU (1949) observed that the parthenocarpic fruits were normal in sugar content. JAKUSKINA (1949) found that the tomato fruits on plants sprayed with 2, 4-dichlorophenoxy acetic acid were richer in ash, P_2O_5 and nitrogen contents.

(*v*) *Histological.*—Gardner and Kraus (1937) studied the histological changes in the normal and seedless fruits of *Ilek opaca*, and observed that the development of fruits was parallel in both the cases. Young ennumerated histological differences in parthenocarpic and normal fruits of cucumber. He observed that in open pollinated ovaries perianth, stigma, nectary and the neck of style shrivelled and dried after a week, and a protective layer was formed next to the live ovary tissue. Hardened seedcoats were present 20 days after pollination, and they contained large ovules. On the other hand the treated ovaries developed into fruits where the seeds lacked endosperm and embryo and also developed smaller seedcoats. When 2 per cent. indole acetic acid was applied, in lanolin apically to the cut surface of the floral tube and the nectary, four days prior to full bloom, apical tumors were formed. Ovules developed to half the normal size and seedcoats were slightly hardened. When the treatments were applied at full bloom the results were intermediate. Britten (1947) compared the development of parthenocarpic and normal caryopses of maize and found that the immediate response of the ovaries to an application of growth substance was a short period of rapid growth of the maternal tissue of the ovary. Later on in the treated ovaries the rate of growth lagged behind. Differentiation of endosperm in the treated ovaries was retarded and abnormal and the mature caryopses were smaller than normal. The author further observed (1950) that the rate of development in the treated ovaries was faster during the first five days. They attained the maximum size in 11 days, after which a shrinkage was observed. Crane and Gaskaya (1950) observed that the development of achenes in fig syconia differed when para-chlorophenoxy acetic acid and gama indole butyric acids were used. In the former the endocarp of achenes remained parenchymatous instead of getting sclerified as in the normal case. When the latter was used, the achenes had no endocarp. Crane (1952) observed three distinct deviations from the normally developed syconia, *e.g.*, (i) Achenes with no endocarp, (ii) Achenes with unsclerified endocarp and lastly the completely sclerified endocarp. Embryos were absent in all the three types of deviations.

(*vi*) *Maturity.*—There is enough conflicting evidence showing that the parthenocarpic fruits may ripen earlier or later; or the maturity may remain unaffected. The responses in this direction differ widely with the species and the chemical used for inducing parthenocarpy. Gardner and Marth (1937) observed that fruits of holly induced by action of naphthalene acetic acid tended to remain green for a longer time. Clark and Kerns (1942) reported that parthenocarpic fruits of pineapple tended to have delayed ripening if high concentrations of naphthalene acetic acid were used. Crane and Blondeau (1949)

observed early maturity in figs following treatment with growth substance. Crane (1953) further observed that the maturity of treated fruits advanced by three to ten days. Zalik, Hobbs and Leopold (1951) observed that the parthenocarpic fruits matured a little earlier.

It would be clear from the foregoing details the subject of induced parthenocarpy has received a large attention in the field of scientific investigations. In some fruits continued and intensive researches have established hormone treatment as commercial practice; as is the case in green-house production of tomatoes. Another aspect, which may perhaps interest the tomato grower in India, is the response of tomatoes to the application of growth substances under field conditions. The studies conducted by Randhawa (1951) and Singh and Kakkar (1952), and the results reported by them, open up a very promising line of work. The results are very interesting and in due course may go a long way towards establishing the hormone treatment of tomatoes as a commerical practice in this country as well. It has been observed at many places that during rains, when there are too many showers and the sky continues to be overcast with clouds for several days at a stretch, fruit set of tomatoes is retarded. This may also be due to the scarcity of light which is reported to hinder fruit set. In such circumstances, application of hormones may provide an answer. However, any chance of exploiting the large information that is available on green-house culture of tomatoes, and the use of hormones in that, remain at present, in the realm of a promising possibility, as green-house production of tomatoes is not practised in India.

On some other fruit plants, such as custard apple (*Anona squamosa*) and Loquat (*Eriobotrya japonica*), where the earlier blossoms do not set any fruit, and are wasted, use of growth substances to induce fruit set or for parthenocarpic development of fruit seems to be very promising indeed. Concerted efforts in this direction are likely to give encouraging results on one hand, and on the other, it would direct the applied research on growth substances to many productive avenues.

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SOME PREDATORS OF MITES IN MYSORE

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Mites, like insects, have varied feeding habits. Some are parasitic living on invertebrate hosts such as insects, and vertebrate hosts, like birds, cattle and even man. Certain of them are scavengers inhabiting dead animal and plant matter. Besides, a large number is phytophagous attacking a variety of uncultivated and cultivated plants. This group contains many species which, at times, become serious pests of some crops as, for example, the jowar mite (*Oligonychus indicus* Hirst) which attacks crops like jowar, sugarcane and areca, the common red spider mite (*Tetranychus telarius* L.) on castor, beans, papaya and a variety of other plants, the areca red mite (*Raoiella indica* Hirst), the fig mite (*Eotetranychus hirsti* Pritchard and Baker) on fig and different species of *Eriophyes* on jasmine, *Crotalaria*, pongamia, cotton, sugarcane, etc. Mite infestations, in general, are seen throughout the year depending on the availability of suitable host plants, and are particularly heavy during the summer months.

The natural enemies of mites constitute mostly predators coming under the two main groups, Acarina (mites) and insects. Amonst the latter, certain species belonging to the orders Neuroptera, Thysanoptera, Coleoptera and Diptera are concerned. There are several cases on record where these predators have been a valuable check on the population of different species of mite pests of crops. Quayle (1938), while dealing with the citrus red mite in California, has stated that the species 'is often greatly reduced in numbers through the attacks of enemies particularly where mechanical control measures, as spraying and fumigating, are not employed'. In India, *Stethorus pauperculus* Wse. and *S. gilvifrons* Muls. exercise a valuable check on the population of mites on various crops such as jowar, castor, beans, apples, etc. (Kapur, 1948). In Mysore infestations of the red spider mite *Tetranychus telarius* L. on a large variety of plants have been reported to be often effectively checked by different species of *Stethorus* and *Somatium oviformis* (Casey) (Puttarudriah and Chenna Basavanna, 1953), and the jowar mite (*Oligonychus indicus*) by *Stethorus pauperculus* (Puttarudriah, 1947).

The previous records of predators on mites in India are scattered and have been included mostly in the biological accounts of individual species of mites. A detailed study of the incidence and biology of the

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predators and the role played by them in relation to the control of the different species of mites may possibly open up means to utilise them in the control of mites, or at any rate, will lead to the realization of their utility and conserving them by avoiding, wherever possible, the application of harmful chemicals, for in many cases the newer organic chemicals are known to affect adversely the insect predators of mites. In the present paper it is proposed to give a list of predators with observations on their incidence and feeding, etc., on mites.

Coleoptera

Coccinellidæ

Stethorus pauperculus Wse.

This is a very common lady-bird beetle found feeding both in its larval and adult stages on the different stages of mites. The common species of mites noticed to be fed upon is the jowar mite, *Oligonychus indicus* Hirst., in Bangalore, Bellary, Mysore, Mandya, Tumkur and Chitaldrug Districts. It is also noted to feed upon the fig mite, *Eotetranychus hirsti* Pritchard and Baker, around Bangalore and the common spider mite, *Tetranychus telarius* L., on castor, pumpkin, papaya, etc. It has also been found feeding on *Eutetranychus banksi* (McG.) infesting castor around Bangalore during November. The predator has been seen amongst mite populations almost throughout the year and it is generally abundant during summer months.

The beetles which are black, oval, with fine pubescence on the dorsal surface are seen actively moving about amidst mite populations, and they generally feed on the eggs of mites by first sucking the contents and then devouring the shell, though they occasionally feed on the other stages of the mites, particularly on the inactive ones, in the same manner. The predator grubs are elongate-oval, flattish, greyish to greyish-red in colour and the dorsal surface covered with small black warts giving rise to short setæ. They are generally seen amidst mite colonies and beneath the web in the case of spider mites, actively moving the head in an attempt to search for the different stages of the mites on which they feed by a process of alternate sucking and regurgitation till the contents of the victim are completely sucked; the egg shell and the empty skin of the mites are not fed upon. This species together with a few other species of *Stethorus* reported here often exercised a good controlling influence on mite populations.

Kapur (1948) has recorded that this species is probably the most widely distributed and common in India and exercised a valuable check on the population of mites on various crops such as sorghum, castor, beans, etc. Puttarudriah (1947) and Cherian (1933) have recorded

this species as an effective predator on the jowar mite (*Oligonychus indicus* Hirst. = *Paratetranychus indicus* Hirst.) in Mysore and South India respectively.

Stethorus gilvifrons MULS.

The beetle is black and oval and covered with fine pubescence. The predator both in its larval and adult stages was seen in large numbers feeding upon the mites (*Tetranychus* sp.?) infesting papaya (*Carica papaya*) leaves around Bangalore especially during the summer months.

This species was till recently known only from North India as feeding upon the mites infesting apple tree and castor (KAPUR, 1948) and was recently recorded from Mysore on the above host (PUTTARUDRIAH AND CHANNA BASAVANNA, 1956).

Stethorus tetranychi KAPUR

Larvæ and adults of this species were found together with the above species on the red mites on papaya around Bangalore. Adults were also collected on mite (*Raoiella indica*)—infested areca palms around Tharikere (Chickmagalur District) during April. The predator has also been found to be feeding on the mites infesting castor.

This species was described from Bengal from the material collected on mite-infested jute (KAPUR, 1948).

Stethorus parcepunctatus KAPUR

This is allied to *S. pauperculus*, but almost circular in outline and convex. The beetles were found feeding on the red mite *Raoiella indica* infesting areca palms around Tharikere during summer months.

This species has been described by KAPUR (1948) from the material from Kanara (India) without any record of host.

Stethorus rani KAPUR

Grubs and adults of the species were found in fairly good numbers amongst the mites, *Eotetranychus hirsti* Pritchard and Baker, infesting the leaves and tender fruits of fig and often cause severe injury, especially during the summer months, round about Bangalore.

The species has not been recorded in South India, and is known only from Raniket, Kumoan Hills, United Provinces in North India (KAPUR, 1948).

Stethorus SP.

This unidentified species has been collected from mite-infested papaya plants during March near Bangalore.

Juaravia soror (WEISE)

A few adults of this species were collected on areca palms infested with the mite *Raoiella indica*, round about Tharikere during April.

MISRA (1913) has recorded the species as a predator on *Tetranychus bioculatus* from Bihar.

PUTTARUDRIAH AND CHANNA BASAVANNA (1955) have given the previous records of hosts for the species which includes the mite, *Tetranychus bioculatus* Wood Mason (KAPUR, 1946).

Spilocaria bissellata (MULS.)

Adults of the species were collected from the red mite colonies (*Raoiella indica*) on areca leaves near Lingadahalli, Tharikere Taluk, during November.

The species has been recorded by PUTTARUDRIAH AND CHANNA BASAVANNA (1955) from Mysore under the name *Coelophora bissellata* Muls.

In addition to the coccinellids mentioned above, the previous records of coccinellid predators on mites in India include *Adalia decempunctata* L. on *Tetranychus telarius* L. from Quetta (North India) (JANJUA, 1942); *Scymnus nubilus* Muls. on *Oligonychus indicus* from Mysore (PUTTARUDRIAH, 1947); *Brumus suturalis* (Fabr.) and *Scymnus* sp. on *Tetranychus bioculatus* on jute and castor from Bihar (MISRA, 1913), *Scymnus gracilis* Mots. as specific on mites (Rahman, 1941).

COLEOPTERA

STAPHYLINIDÆ

Somatium oviformis (CASEY)

This is a small, shining black rove beetle about 1 mm. long with short wing covers and with the tip of the abdomen strongly curved upward. The species is frequently seen in large numbers in association with red spider mites (*Tetranychus* spp.) infesting a large number of plants like pumpkin (*Cucurbita maxima*), cucumber (*Cucurmis sativus*), cowpea (*Vigna catjang*), *Ipomœa* sp. and cotton. The larva is elongate, about 2·5 mm. long, yellowish brown to pinkish brown in colour, and clothed with short fine scattered shairs.

The adults and particularly larvæ feed on all the stages of the mites. They feed by a repeated process of alternate sucking and regurgitating the contents of the alimentary canal into the body of the mite, till body contents of the latter are completely sucked in. The details of this method of feeding have been recorded (PUTTARUDRIAH AND CHANNA BASAVANNA, 1953).

QUAYLE (1938), who records the feeding capacity of the species on the citrus red mite (*Paratetranychus citri* McG.) in California, states that a single predator larva consumes more than 200 or 300 mites during its entire life of 10–15 days and the adult over 300 mites during its entire period of about 30 days.

MISRA (1913) has recorded an unidentified staphylinid beetle on *Tetranychus bioculatus* from Bihar.

COLEOPTERA

NITIDULIDÆ

Cybocephalus semiflavus CHAMP. VAR.

The adults of this species were collected during April amongst the mite colonies (*Raoiella indica*) on areca leaves around Tharikere. No larvæ of the species could be seen at the time.

The genus *Cybocephalus* is known to be predaceous both in the adult and larval stages upon Coccidæ, most frequently of the Diaspinæ (CLAUSEN, 1940).

COLEOPTERA

DERMESTIDÆ

Aspectus indicus ARROW

The beetles of this species were noticed along with the above nitidulid on mite-infested areca leaves during April near Tharikere.

THYSANOPTERA

THRIPIDÆ

Scolothrips sexmaculatus PERGANDE

The adult is pale yellow with the forewing marked with three brown spots. Both in the larval and adult stages, the thrips feed on the eggs of mites and rarely on the young ones. During the process of feeding they suck the body contents of victim through a number of punctures made successively by means of the mounth parts. The adults and nymphs were observed in small numbers amongst the mites infesting pumpkin and cowpea plants.

AYYAR (1928) recorded the species as feeding on the mites infesting Cholam (*Andropogon sorghum*) from Coimbatore.

NEUROPTERA

CHRYSOPIDÆ

Chrysopa SP.

Occasionally larvæ of *Chrysopa* sp. have been observed on mite-infested castor and cotton plants during April–July around Bangalore.

These do not appear to be specific on mites and further they are seen only in negligible numbers.

NEUROPTERA

Hemerobiidæ

Hemerobius Sp.

The larvæ of this species, appearing almost like the *Chrysopa* larvæ, have been occasionally seen amongst the mites on cotton and cowpea.

Pruthi and Mani (1945) record *Chrysopa* sp. and *Hemerobius* sp. as feeding on *Paratetranychus citri* McG. in India.

HEMIPTERA

Anthocoridæ

A dark brown, small anthocorid bug (? *Triphleps* sp.) has been noticed commonly in small numbers on mite (*Eotetranychus hirsti*)—infested fig leaves near Bangalore. Reddish-brown nymphs of this bug were also observed.

ACARINA

Gamasidæ

An unidentified pale yellow gamasid mite was occasionally seen feeding on mites infesting fig and areca around Bangalore.

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SOME ASPECTS OF PADDY IMPROVEMENT IN THE DISTRICT OF SOUTH KANARA

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With an acreage of nearly five lakhs, paddy occupies eighty per cent. of the cultivated area in the district of South Kanara and is almost the only cereal grown there. Though the conditions under which it is grown might appear to be uniform to the casual observer, the factors governing yield are quite diverse and a detailed knowledge of these is useful alike to the research worker tackling the problems of the district and the cultivator desirous of getting the best of his land. An attempt is made in this article to describe briefly some of the salient features governing the cultivation of paddy in the district.

Season and Water Resources

The first crop, which is the main crop, depends entirely on the south-west monsoon which unfailingly brings torrential rainfall amounting to over one hundred inches from the beginning of June to the end of September. But the distribution of the same can be most erratic and is possibly the biggest single factor governing yield during the season. Delay in the break of the monsoon after the receipt of the pre-monsoon showers usually causes the seedlings to get aged at the time of transplanting. At the same time, if the monsoon breaks out very early, the seedlings may not be ready for being planted out with the first rains. The belief among the cultivators that early planting is almost equivalent to the best form of manuring probably has a sound basis as it is likely that the first rains bring down a considerable amount of ammonia from the atmosphere which can be retained only if the soil is puddled without delay and planted with a crop. It has been estimated that rain-water easily adds 4–8 lb. of nitrogen per acre. Further, paddy is a crop which loves warmth and it cannot fail to get a good start if planted out early when the atmosphere is still warm. Wherever facilities exist, cultivators have found it worthwhile to bale out water with pumps and plant the crop in time. The nature of distribution of rainfall continues to be an all-important factor right up to the harvest of the crop. While the absence of rains for even two to three days causes the complete drying up of the fields situated higher up in the single crop area, an excess of the same at the time of flowering and thereafter interferes with the setting of the grains and induces lodging. The introduction of drought resistance in the strains intended for the higher single-crop land and the

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induction of the non-lodging character into those meant for the double-crop land are desired at in any comprehensive breeding programme for the district.

The second crop depends upon the water let in or baled out from channels, streams and small rivers across which temporary dams are put, by individual or collective effort. In the latter case, there is always considerable delay in water being made available for irrigation as the necessary co-operation may not be forthcoming and there are several instances wherein the construction of temporary dams and the cultivation of second crop under it has been completely abandoned for want of co-operation among the cultivators in a village. In several villages, there are also large wells, the supply from which has become meagre for want of a programme of silt clearance. The area under second crop could doubtless be greatly increased if an agency were to be set up for bringing about the necessary co-operation among the villagers and tapping all the available sources of water including the installation of large pump-sets along river banks in the upper reaches where the water is not brackish.

The problem of drainage has assumed importance and vast stretches of land are found to get submerged and the crop destroyed during the first crop season. It is found on enquiry that the first crop was growing normally in these areas in former years but the drainage channels serving these fields are now silted up and are unable to carry off the excess water since the level of drainage channels is very much higher than the adjoining fields.

Manures and Manuring

Manuring is particularly important in this region because the soils are generally light in texture and poor in nutrients. The lime status is low and the pH ranges from 5·5–6·5. A judicious combination of organic and inorganic manures would improve the physical condition of the soil and improve its yielding capacity. Green matter is ordinarily not applied as such to paddy fields in this district. The problem of supplying green leaf, particularly to the first crop, is not an easy one. The cultivator generally makes an all-out effort to transplant the crop very early for the reasons already discussed whereas the proper use of green leaf necessitates an interval of at least a week between application and transplanting. In the early stages of anaerobic decomposition (of green matter), certain toxins are produced which are harmful to plant growth. When seedlings are planted immediately after the application of a heavy dose of green leaf, gaps are sometimes found to occur in the crop which may be attributable to the effect of toxins upon young plants. In addition to these problems, there is the question of

the supply of green leaf itself. It is common for visitors from other parts of the country to remark that in a region endowed with forest wealth as this district is, it should be superfluous to grow green manures and leaf-yielding shrubs. What is not fully realized is the fact that the forests are often situated far off from the paddy fields, that these contain only a small proportion of leaf-yielding trees and further that whatever is collected has to be brought to the fields only in the form of headloads as there is rarely a road leading from the forest right up to the fields. At a time when all the available labour is feverishly engaged in ploughing fields and transplanting, it is impracticable to divert labour for bringing headloads of green leaf from great distances. The growing of green manures in and leaf yielding shrubs and trees around paddy fields is as important in this district as in any other region.

Reverting to the use of green leaf during the first crop season, one has to face the fact that it may not be practicable to leave an interval of anything more than 2–3 days between the application of green leaf and the transplanting of paddy seedlings. Experiments designed to determine the extent of toxic effect as also the minimum time required for proper decomposition would prove of much practical value.

Among the green manures tried, *Kolingi* (*Tephrosia purpurea*) alone has stood the test of time and is undoubtedly the most suited to this district from the practical point of view. Its chief merits are that it is not eaten by cattle and it is able to subsist on the minimum of moisture. In a region where holdings are fragmented and cattle are allowed to stray even when paddy nurseries are being raised, it is of little avail growing green manure crops which are eaten by cattle. The crop of *Kolingi* lends itself to being grown successfully under a variety of conditions. Sown pure or as a mixture with pulse a few days prior to or after the harvest of first crop paddy in September–October in single crop land, it grows slowly and just manages to survive till the receipt of the pre-monsoon showers in the following May, after which it grows rapidly to give about 3,000 lb. of green matter per acre at the time of planting the paddy crop. In double crop land, it can be sown either pure or as a mixture with pulse after the harvest of second crop paddy and here also, it is ready for being ploughed in during the following first crop season. In certain classes of second crop land, there is excessive moisture at the time of harvesting second crop paddy so that the plots cannot be ploughed for a long time afterwards and in such fields the seeds can be sown a week prior to harvest. Whenever sowing as a mixture with pulses, it may help distribution better if the two are sown separately one after the other instead of being mixed and sown. As *Kolingi* has a hard seed-coat, pre-treatment of the seed either by pounding it lightly with coarse sand or soaking it in water for a day is an essential process

for ensuring proper germination. The seeds should be made available to the cultivators at the right time. Contrary to the common notion that farming is a leisurely occupation, time is often a critically important factor in good agriculture. Unless the seed is readily available at the time of sowing, a whole season is missed and the seed left over is not useful even for the next season as it loses viability. In the matter of seed supply the motto may well be " better never than late " because unsold seed of the previous year is liable to get mixed with fresh seed.

As much as *Kolingi* is the most suitable for being grown in the field itself, *Glyricidea maculata* is the most suitable for being grown on the high bunds and barren places around paddy fields. Soon after the receipt of the pre-monsoon showers, the shrubs put on a mantle of fresh green shoots which can be cut and applied for first crop paddy. Planted either as cuttings or as seedlings in well-prepared pits soon after the receipt of pre-monsoon showers, it establishes and grows into a sturdy shrub in three years without any further attention. Even if only 25 per cent. of the seedlings were to survive, persistent efforts over a few years would establish a large number of shrubs which could easily meet the green leaf requirements of a holding. The shrubs grow luxuriantly during the monsoon months of June–September and an abundance of leaf can be obtained for application for second crop paddy. It has been observed however that, when cuttings are taken at the end of the monsoon season, the shoots grow very slowly during the following months when very little rainfall is received and they produce very few pods. It is therefore not very desirable to prune the plants in October if large quantities of seed are required to be produced in the following summer.

It is not as though the possibilities and advantages of growing green manure yielding trees and shrubs have entirely escaped the attention of the local cultivators. Though slow in growth, the *Daddalu* (*Careya arborea*)[1] is well adapted for growing on the bunds of paddy fields and a single tree yields hundreds of pounds of leaf at a single cutting. In some holdings including the one that formed part of the area now occupied by the Paddy Breeding Station, Kankanady, these trees are found in plenty on the field bunds which speaks well for the wisdom of the cultivators who had encouraged them to grow. Even mango leaf is considered excellent manure for the paddy crop and planting wild varieties, wherever possible, would serve the multiple purpose of providing green leaf, fruit, fuel and timber.

The local system of production of farm-yard manure might have originated as a sound form of composting green leaf and all available wastes but now stands in sore need of improvement. The loose box

[1] Ceylon oak: also called ಗುಡ್ಡದ ಇಸ್ಪೆ, ಹೆಣ್ಣುಮುತ್ತಿ, ದದ್ದಾಲ.

type of cattle-shed compels the cultivator to bring at least one head-load of green leaf daily to provide bedding for the animals. The task of obtaining green leaf for a crop is thus spread over several months which mitigates the problem of labour in the case of the small cultivator. After the harvest of the paddy crop, some cultivators pull out the stubbles and fill them into the loose box. This not only helps the physical disintegration of the material but also narrows down the carbon-nitrogen ratio in the same thus enhancing its manurial value. The manure thus obtained is, however, most often heaped in a corner of field and completely left to the mercy of the three elements till it is required for the next crop. Much of the plant food in the manure is doubtless lost through the leaching action of rain and some of the nitrogen may escape as gas. There is a tendency among the cultivators to think and argue that washings from the field flow only into the field after all and are therefore not lost for good. But it is observed in practice that there is nothing but rank growth and lodging in and around the region where the manure was heaped.

It is doubtful if the digging of pits for the purpose of composting is quite so useful in this district. These pits get filled with purcolating water during the rainy season and, since the soil is very porous, plant foods may be lost by leaching. It would be far more preferable to construct an enclosure on slightly raised ground by putting up mud walls and to roof it over with cheap material. Into this covered enclosure may be transferred the contents of the loose box as well as any rubbish collected separately.

The use of fertilizers is increasing rapidly and the results of several trials in cultivators' fields have indicated the good response of the paddy crop to a combination of phosphatic and nitrogenous furtilizers. A combination of 30 lb. nitrogen and 30 lb. phosphoric acid per acre would be a safe dose for all the plots. Although ammonium sulphate and urea have been found to be equal in their effectiveness on an equal nitrogen basis, urea is more neutral in its reaction and is the more suitable to that extent to the acid soils of this district. But the fertilizer forms itself into lumps of various sizes in the humid climate of this region and very few *ryots* would have the patience required to break it into fine powder before application. Ammonium sulphate is easier to apply on account of its excellent physical condition and greater bulk on an equal nitrogen basis. It is often suggested that urea may be mixed with an equal quantity of sand to increase the bulk but, very often, the sand obtained is moist or wet containing an admixture of soil and, when the fertilizer is mixed with such a material, the purpose is defeated by the whole mixture converting itself into a sticky mass dripping with water. Phosphates by themselves have been found to give only negli-

gible increases in yield at the 20 lb. level of phosphoric acid but their effect in the presence of nitrogen has been found to be very marked. Even though the soil reaction is acidic with the pH ranging from 5·5–6·5, triple superphosphate has been found to be as effective as bone-meal but a neutral fertilizer should prove a welcome substitute for triple superphosphate in the acid soils of the region. A mixture of finely ground rock phosphate and superphosphate has been found to yield very encouraging yields elsewhere and the same deserves to be tested in this region at the earliest opportunity.

As regards the method of application, there is scope for applying the phosphates deep by dropping the fertilizer into the furrow just behind the plough. But such painstaking methods are not popular with the average cultivator and broadcasting the fertilizer before the commencement of ploughing on the day of planting or sowing should ordinarily prove sufficient. In the case of nitrogenous fertilizers, top dressing during the first crop season is risky as heavy showers may occur soon after the application and wash out the fertilizers. It is preferable to apply about two-thirds of the total quantity before the commencement of ploughing on the day of planting so that the fertilizer gets thoroughly worked into the soil during the process of ploughing and is thus prevented from being easily lost. The balance of nitrogen can be applied as top dressing when the weather is bright.

The majority of cultivators feel that the use of fertilizers, particularly ammonium sulphate, has definite deleterious effects on the soil such as making the soil hard and increasing the need for water. It is argued that fertilizers destroy the micro-organisms and even earthworms in the soil rendering it sterile and incapable of producing good crops except with the applications of increasing doses of fertilizers. These complaints are voiced even by *ryots* who regularly use fertilizers, The low lime status of the soil and the insufficiency of organic matter may be partly responsible for the undesirable reactions and a comprehensive experiment to test the deleterious effects of the continuous application of fertilizers with and without lime and green leaf is desirable.

The use of improved strains is spreading rapidly and some of them are so popular that they are given a local name and are looked upon as local varieties. The fields even in a single village vary widely in their level of fertility, availability of water, facilities for drainage, time of planting and a host of other factors and a wide range of strains is required for meeting the individual requirements of fields. An earliness of even as little as five days often proves of critical importance in several fields during the first crop season. In a region of such high rainfall, it is rather strange that limitation of water-supply is an important factor restricting yields. On the other hand a long duration variety

like Co. 25 is necessary for getting the best out of lands having a plentiful supply of water during the second crop season.

The strains introduced from other parts of the country have generally proved more popular than selections from the local varieties. This is partly because the introduced strains possess certain distinctive features and are more easily identified than selections from local varieties whose merits, when present, can be ascertained only by regular trials to which most of the cultivators are not favourably inclined. It is a fact of course that the introduced strains which have been adopted in the district are either generally higher yielding or they possess certain desirable physiological characters like non-lodging and non-shedding. An example of the former is the strain MTU. 3 which does not lodge in spite of very heavy manuring, submersion during floods and rainfall at the time of harvest. An example of the latter is the variety PTB. 9 which has found favour with the *ryot* even though the quality of the straw is not quite up to the mark. A strain isolated from a local variety and giving a mere 10–15 per cent. increased yield over the local does not appeal to the cultivator and easily gets lost with the local variety in the course of a few years. To prove popular with the cultivator, a strain from a local variety should consistently record at least 50 per cent. increased yield over the local or it must be different in appearance from the local variety and possess to a distinct degree, such characters as earliness, resistance to lodging and shedding but yielding at the same time at least as much as the local.

Some of the second crop strains like Co. 3 and Co. 14 are capable of yielding twice as much as the local variety of *Athikraya* if grown under favourable conditions. These are season-bound varieties which flower in the third or last week of December and the transplanting has to be done at least in the third week of October to allow sufficient time for their proper growth. Since first crop harvests progress almost side by side with second crop planting, labour is an acute problem at the time of second crop planting. Further, the preparation of the fields can sometimes be taken up only after temporary dams have been put across streams in several cases which usually gets delayed for the reasons already discussed. Due to all these causes, the planting of the crop is very often delayed till the last week of October or even the first fortnight of November. Several years' observations both at the Paddy Breeding Station, Kankanady, and in the district have tended to confirm the impression of the author that the end of the third week of October is a critical stage beyond which planting either Co. 3 or Co. 14 would not ordinarily result in anything like a good crop. Growing these varieties therefore means a race with time if a good, above the average crop is the aim. With the strain GEB. 24 which flowers in the last week of

November, the critical period for planting is even as early as the beginning of the second week of October.

The need for planting early creates certain problems in the raising of the nursery. When the local variety *Athikraya* is planted, the normal practice is to raise the nursery after the harvest of first crop paddy which may be in the first or second week of October. With strains like GEB. 24, Co. 3 and Co. 14, which have to be planted early as discussed above, the sowing of the nursery has to be done in the second or third week of September if the seedlings are to be ready in time. The common first crop varieties like *Kayama* are ready for harvest only in the first week of October at the earliest. The idea of leaving a plot fallow during the first crop season, even though sound, does not appeal to the average cultivator. In such cases, it has been found practicable to grow a crop of PTB. 10 which can be harvested off in the second week of September to make room for second crop nursery.

The raising of the semi-dry nursery during the second crop season is really an ingenious method adopted by the *ryot* to get over certain problems ,confronting him during the season. Sown as early as the second week of August, the seedlings keep on without overgrowing or forming nodes till the last week of October or the first fortnight of November. This is achieved by cutting off the supply of water to the nursery as soon as the seedlings have made a little growth. At the time of pulling out for transplanting, the seedlings present a dried up appearance. The semi-dry method of raising nursery is invariably adopted in the case of long-duration varieties like *Kandrakkuity* as it helps, within limits, to advance the time of flowering. In the case of certain improved strains like Co. 3 and Co. 14 where the seeds lose their viability during the monsoon months, it is found that the percentage of germination is satisfactory if the semi-dry method of raising nurseries is adopted as the seeds are then sown fairly early in the season before they begin to deteriorate. The seedlings from the early sown semi-dry nurseries do not grow quite as vigorously as those taken from the wet nurseries.

The deterioration of the seed in the case of certain popular second-crop strains like Co. 3 and Co. 14 is a problem that has not yet been solved. When the seeds are stored in straw twists according to the local method, they fail to germinate when sown at the end of the monsoon season. Though storing the seeds in kerosene tins may slightly reduce the loss of viability, it is not altogether a satisfactory solution. Evolution of a strain which resembles Co. 3 in all characters including its yielding capacity but the seeds of which do not lose viability when stored according to the local method seems to be the only desirable solution.

The fixing up of a suitable strain or a combination of strains to suit the individual conditions of a field or a given set of circumstances forms an important part of extension work. In certain fields of the Majal type at the Paddy Breeding Station, Kankanady, the supply of water is more than adequate for raising a single (first) crop of medium duration but not quite enough for raising two crops. Before the acquisition of the fields for the station, the cultivators were raising only one paddy crop of medium duration followed by a pulse crop. After the starting of the station, it has been found possible to raise two crops of paddy in the same fields by growing the somewhat short duration crop of *Mascathy* during the first season followed immediately by the still shorter duration crop of GEB. 24 which is ready for harvest in the last week of December.

If nurseries for the second crop have to be raised only after the harvest of first crop paddy, it is possible that the varieties which come up best under these late sown conditions may be different from those that come up best under early sown conditions. There are indications to the effect that even a broadcast crop of PTB. 20 may score over several other improved strains if the latter are sown late. Similarly during the first crop season, it may be more preferable to broadcast PTB. 10 early in June than to attempt to raise nursery with any other strain when one is faced with the problem of lack of seedlings. There is obvious need for conducting inter-strain trials under different sets of conditions such as early and late sowing, broadcasting and transplanting, etc., to ascertain the suitability of each strain to the different conditions.

The Japanese method of cultivation has not found as much favour in this district as it is reported to have done elsewhere in the country. An important feature of the Japanese method of paddy cultivation is the transplanting of seedlings in lines to facilitate the working of the inter-cultivator which again is primarily intended to facilitate the aeration of roots. By cutting up older roots, inter-cultivation stimulates the production of fresh young roots. "The roots of paddy plants are believed to diffuse oxygen, *younger roots* diffusing more oxygen than the older roots, and keep an oxidizing environment in the vicinity of the roots" (Natarajan *el al.*, 1957). In heavy, deep soils the use of an intercultivating machine is easy and the need for creating special conditions for the better aeration of the roots is also obvious. The need for improving aeration in the light shallow soils of this district must be much less and the movement of the intercultivator is also rendered more difficult as the soil is hard. It has so far not been possible to establish the clearly beneficial effects, if any, of interculture alone at the Paddy Breeding Station, Kankanady. But the use of the intercultivator helps in the better incorporation of manures and to that extent, interculture should definitely prove

beneficial if it is carried out soon after the application of phosphatic, nitrogenous or potassic fertilizers as top dressing.

Thorough ploughing is important in this region as the soils are light and harden soon after ploughing. In certain instances planting has to be done almost behind the pairs and the practice of planting a day after the puddling is almost unheard of. Good ploughing is particularly important in the single crop lands as it improves the water-retaining capacity of the soil. The importance of proper ploughing is fully recognized by the cultivator and the prosperity of the *ryot* is very often gauged by the condition of his working animals. During the planting season, not all the available animals are sufficient for coping up with the ploughing to be done. At the same time, too many animals cannot be maintained as they have to remain idle during the greater part of the year. A light tractor that can plough in puddle would be a boon to the district. The usual type of rotary puddlers are unsuited to the light, shallow soils of this district.

The problem of keeping up the purity of the seed is particularly difficult in this district. In the first place, dry nurseries are raised during the first crop season in fields where a crop had been grown in the previous season. Along with the seeds sown in the nursery, the grains which had shed from the previous crop germinate and these plants also get transplanted into the main field to produce rogues. The first crop lodges soon after flowering on account of the showers received in the month of September. There is therefore practically no scope for carrying out any thorough rogueing. The average cultivator keenly resents any attempts at rogueing partly due to sentiment and partly because it predisposes the crop to lodging. Any programme of seed multiplications that depends on rogueing for maintaining the purity of the seed during the first crop season is doomed to failure. The only practical method of maintaining the purity of the seed is to eliminate contamination of the seed *at the source*. So far as the seed requirements of individual holdings are concerned, the following simple method can be followed for maintaining the purity of the seed. Each year, three pounds of seed can be easily handpicked from a heap of sheaves after harvest. After the onset of the monsoon in the following season, this quantity can be sown in a wet nursery over one cent. The seedlings can be planted in lines late in the season (when there is no scarcity of labour) over an area of ten cents. This area of ten cents can easily produce 150 lb. of seed of very high purity with very little or no rogueing. But most cultivators take their requirements of seed only from the bulk crop and complain that the seed has got badly contaminated. If the method described above is followed, there should be no need for them to renew their seed from Departmental stocks for a number of years.

The problem of maintenance of purity of seed is much less difficult during the second crop season as seedlings are raised in wet nurseries and rains rarely occur after the flowering of the crop to cause lodging and difficulty in rogueing.

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CONTROL OF COCKROACHES BY APPLICATION OF TUGON (1% DIMETHYL HYDROXY-TRICHLORO-ETHYL PHOSPHONATE)

By D. V. Murthy*

Introduction

About four species of cockroaches are known to occur in our country. They are *Blattella orientalis* Linn., *Blattella germanica* Linn., *Periaplaneta americana* Linn. and *Periaplaneta australasiæ* Fabr. They are brown to brownish black in colour and have flattened oval bodies, which enables them to hide in cracks and crevices. In dwelling apartments they damage many kinds of foodstuffs, papers, etc., and cause filth and annoyance to inmates. They are also said to be sometimes carriers of human diseases such as cholera, typhoid, dysentery, tuberculosis, etc.

Life-History and Habits

The adults mate soon after maturity. The eggs are laid in small capsules known as *ootheca*, which are sometimes seen projecting from the abdominal tip of the adult female, which hatch in about 1½ months. Their development into mature adults takes a considerably long period —6–12 months—depending upon many factors.

Cockroaches are mainly active at nights and appear to prefer dark. In households they are mostly observed in kitchens and stores. They thrive in warm and humid environments.

Control Measures

Apart from scrupulous cleanliness without which no control measures are effective, some of the recent methods advocated for the control are dusting or spraying area where cockroaches congregate or hide with B.H.C. or D.D.T. or Chlordane or Sodium fluoride (Niswander and Davidson, 1948) and in cases of severe infestation fumigating with hydrogen cyanide. Fumigation is however not possible in ordinary households.

"Tugon" Bait

The writer had occasion to conduct some preliminary trials recently with a proprietary roachicide known as "Tugon" supplied by Ms. Rangaswamy & Co. which is said to contain 1% Dimethyl-hydroxy-trichloro-ethyl-phosphonate and which has been found quite encouraging. The material is available as small bluish black crystals. The

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trials were conducted in a household kitchen and stores which were heavily infested with cockroaches. The bait was sprinkled thinly during night at such places where the cockroaches were found to congregate in numbers. The material was removed by sweeping next morning.

The testing of efficiency of any control measure on non-stationary insects like cockroaches is not easy. It is difficult to compare the population density, before or after treatment, since experimental areas are subject to reinfestation from neighbouring areas. In view of this an attempt was made to test the efficiency of the above bait on the following two basis:—

(1) Daily count of dead cockroaches.

(2) Visual estimation on the abundance of the insect in the experimental area.

Before starting of the application of " TUGON " bait, estimation of the cockroach population and mortality (apart frrom experimental if any) was observed for 3 days. The results before and after the treatment are given below:—

Table showing results obtained with TUGON-*baiting for Cockroaches*

Date	Visual estimation of cockroach population in a kitchen of area 12′×8′	No. of dead cockroaches	Remarks
4–5–1957	40	Nil	No treatment
5–5–1957	35	Nil	,,
6–5–1957	50	Nil	,,
7–5–1957	50	Nil	Treatment started
8–5–1957	30	13 (Mostly adult cockroaches)	Treatment in progress
9–5–1957	12	20 (Mostly adult cockroaches)	,,
10–5–1957	2	5 (Mostly adult cockroaches)	,,
11–5–1957	6	..	Treatment stopped
25–5–1957	5	..	..

The results show that the estimated population of cockroaches has come down remarkably due to TUGON-baiting. Further observations will be made as and when opportunity arises.

I am grateful to Dr. M. Puttarudriah, Government Entomologist, for perusing the note and offering suggestions.

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FRUIT 'IMMIGRANTS' OF COORG

By Dr. K. M. Aiyappa and P. P. Nanjappa*

Introduction

Fruits are admittedly nature's best devices for keeping mankind healthy and happy. As protective food the value of fruit is very high, as most of them contain both vitamins and health-promoting properties. Of the several reasons put forward for advocating more fruit consumption, their food value, delicious and appetising taste, flavour and its high medicinal value are most important. As such the importance of fruit in our diet is widely and wisely accepted. Hence the value of any fruit requires to be judged from all these view points and Coorg mandarins owe their importance mainly by virtue of low cost of production, superior colour, taste and vitamin content.

Man's primary need is sustenance and strength to live and to admire the æsthetic side of life. He must be a worthy citizen of a country in which he lives. This fact emphasises the need to bring him up on a diet which produces reasonably strong man with healthy attitudes. This would be impossible unless into the common diet enter fruits and vegetables in greater quantities than they do at present. It is a good augury that the Central Government has in recent times realised that fruits and vegetables are necessary part of food and have taken measures to provide better incentives to growing of more fruits and vegetables. If we are indifferent to that industry (and it is the case at present in Coorg as coffee is more remunerative) we only ignore the means of bringing about our economic prosperity and improvement of national health especially in a State like ours which enjoys the most favourable conditions for fruit production at a cost which will defy competition.

Towards this end the erstwhile Coorg Government in co-ordination with the I.C.A.R.[1] had shown a keen desire to step up horticultural research in Coorg and established one of the finest Research Stations at Chethalli. The main work of the Station is to conduct research mainly on orange and its production at cheap cost, and in addition as a part of technical programme this Station has taken up the introduction of various fruit plants for adaptive trials under *malnad* conditions.

It is worth recalling to mind how much we owe our horticultural wealth in Coorg to several fruit immigrants from outside Coorg. Even

* Orange Research Station, Chethalli, Coorg District.

[1] Indian Council of Agricultural Research.

though O'Connor mentions the flourishing orange gardens in Coorg in 1815 when he surveyed it and Richtor giving an account of fruit trees in Coorg in 1870 says " the oranges are celebrated and are as common as plantains", the sweet orange and mandarin orange are considered natives of China and Cochin-China, the pomelo comes from Malaya and Polynesia, the papaya and pineapple from South America, the pomegranate from Persia, the custard apple from South America and West Indies, the fig from South Arabia, the sapota from Tropical America and even the guava so common in Coorg belongs also to Tropical America.

The up-to-date collection of various fruits in the Research Station, Chethalli, Coorg, and a note on their performance in the farm and outside in Coorg are as below:

(*i*) *Mango* (*Mangifera indica*).—The mango has adapted well in every household of Coorg, and the most popular varieties are Raspuri, Badami, Mulgoa, and Totapuri. Several wild types are also observed. The total number of varieties under study in the Orange Research Station, Chethalli, is 20 comprising of early, medium and late varieties. Some of the varieties were introduced from Saharanpur Research Station, Uttar Pradesh. The aim of the introduction of more number of varieties is to isolate more promising early varieties for multiplication and distribution. Except in Fraserpet and Sanivarasanthe, mangoes are confined to kitchen gardens only in Coorg, as for commercial proposition, the harvesting season commences during heavy showers.

Citrus

Several varieties and species have been recognised in Coorg and the most popular varieties are Coorg mandarins and limes. Lime is the earliest fruit to come to bearing. The area under Coorg mandarin exceeds 20,000 acres. In recent years this industry has been experiencing severe setback in production. At present total number of varietal collections in citrus is 120 comprising of loose jacket oranges, sweet oranges, sour oranges, limes, lemons, etc., in the Research Station.

Deciduous Fruits

Plum, pears, peaches and apples also have been introduced in this Station. Most important varieties are Hale, Gaviota and Shiro under plums, Kieffer under pears, Rome Beauty under apples. Nearly 100 plants were distributed under these fruits in Coorg, from the Station. There is great demand for these fruit plants too.

Other Fruits

Among other fruits avocado pears; pomegranates varieties (Kabul and Basin seedless); guava varieties (Allahabad and Safeda); sapota

varieties (Long and Cricket Ball); fig; loquat; tree tomato variety (Purple); Bull's Heart; star gooseberry; cherrimoyer; grapevine varieties (Bangalore Blue and Anab-e-Shahi); pasion fruit (Purple); bananas varieties (Hoobale and Nendran); raspberry; strawberry; papaya varieties (Honeydew, Wishington and Ranchi); sour sop; mangosteen; litchi; pineapple varieties (Mauritius and Kew pine) have adapted well and most of then have proved to be worthy of multiplication and distribution.

Apart from the above fruit plant introductions, several other horticultural plants like cacao, vianilla, cashew, etc., are being introduced in the form for adaptive trials under *malnad* conditions of Coorg and surrounding areas.

The foregoing introductions have definitely proved the possibilities of undertaking the introduction of more kinds and varieties of fruits to isolate the promising ones for commerical proposition.

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Research Notes

THE USEFULNESS OF 'TRAP CROP' IN THE CONTROL OF THE PADDY STEM-BORER—*SCHENOBIUS INCERTELLUS*, WLK.

By M. Puttarudriah and M. Appanna*

During March 1950, in a locality, Lokasara—near Mandya, large numbers of paddy stem-borer moths were observed on an isolated plot of paddy grown for the first time, in that area, there being no paddy crop around in the vicinity. This was rather very unusual, and it was surmised that these moths were attracted in such large numbers to the green paddy crop because of the absence of the crop roundabout. Based on this assumption it was further conjectured that moths emerging early in the season would be attracted to crop grown earlier to the season in small patches. Thus the idea of laying 'trap crop' nurseries took shape and a regular programme was gone through for three years.

Method

One *Gunta* (1/40th of an acre) nurseries were raised in paddy growing plots at Mandya, Hebbal, and Nagenahalli Agricultural Research Stations in both the seasons of the crop. The plots were raised about a month earlier to the general crop, to have a green stand of paddy crop. The infestation studies related to the collection of moths during the period of the raising of the trap crop and the transplanting of the general crop; the collection of egg masses in the trap crop during that period; counting of 'dead hearts' due to stem-borer during the same period. The trap crop was invariably ploughed down as soon as the general crop established itself. Thus the trap plots lased about 2½ months to 3 months. The observations so far made have not given any indications to show that the trap crops serve any useful puprose in attracting the early emerged moths. It has been observed that the trap crops in both the seasons were not in any way infested. In one season in the trap plot at Mandya 2 moths were collected and these collections were made at a time when the moths appeared on the general crop. In another locality, at Ganesha Farm, Bangalore, recently, it was

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observed that the nurseries of the summer paddy were free from infestation and the transplanted crop was later found to be infested by moths which successfully laid eggs. The same phenomenon was observed during the rainy season.

From the above observations, it seems that the most important factor to be considered in the usefulness or otherwise of the trap crop is the period of emergence of moths. It is seen that while the trap crop is free from the insect trouble, the insect makes its appearance in the transplanted crop. This may be due to the fact that the moths, be they breeding in the area or are attracted from other areas, do not emerge at the time the trap crop is raised. This is of no avail in the control of the borer. Should it be suggested that the trap crop be raised to synchronise with the moth emergence and thereby put off the general sowing and planting of paddy by about a month or more the disadvantages are too many as it would interfere with agricultural operations.

(Received: 2nd August 1957)

THESE FASCINATING INSECTS

By S. Usman*

Nineteen centuries ago people believed that hind legs of the Orienta locusts were used for saws, that butterfly eggs were drops of solidified dew, that echoes killed honey bees, and that gold was mined in the mountains north of India by a giant ant " the colour of a cat and as large as an Egyptian wolf".

" This gold, " Pliny the Elder wrote in his natural history in Rome, " is extracted in the winter and is taken by the Indians during the heats of summer while the ants are compelled by the excessive warmth to hide themselves in their hordes. Still, however, on being aroused by catching the scent of the Indians, they sally forth and frequently tear them to pieces, though provided with the swifted camels for the purpose of flight, so great is their fleetness, combined with their ferocity and their passion for gold".

A century ago William Kirby and William Spence described the metamorphosis of a moth in the early pages of the pioneer entomology in the following terms: " were a naturalist to announce to the world the discovery of an animal which first existed in the form of a serpent; which then penetrated into the earth, and weaving a shroud of pure silk of the finest texture, contracted itself within this covering into a body without external mouth or limbs, and resembling, more than anything else, an Egyptian mummy; and which, lastly after remaining in this state without food and without motion .... should at the end of that period burst its silken cerements, struggle through its early covering and start into day a winged bird—what think you would be the sensation excited by this strange piece of intelligence ? After the first doubts of its truth were dispelled, what astonishment would succeed ! Even the most torpid would flock to the sight of such a prodigy."

An eloquent expression of the amazing strangeness of the familiar insects !! (*Abstracted*, Teale, E. W., Oddities of the Insect World. Insects, *The Year-book of Agriculture*, 1952, *U.S.D.A.*)

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Book Reviews

CENTENARY SOUVENIR OF LALBAGH BOTANICAL GARDENS. By M. Dwarakanath Sharma. August 1957. (Mysore Horticultural Society, Lalbagh, Bangalore-2), Pp. 126. Price Rs. 5·00.

The period 1850–60 in India was a decade of intense ferment, expansion and progress. This was the period when, besides the War of Independence, Posts and Telegraphs were introduced, Railways were constructed, the Geological Survey was started and the great Universities of Madras, Bombay and Calcutta were established.

This was also the period when the famous garden of Hyder Ali, south-east of Bangalore City, became the Botanic Garden of Mysore due to the vision and enterprise of Dr. Cleghorn, the Chief Conservator of Forests in Madras.

To mark this great event in the development of Horticulture in the State, the Mysore Horticultural Society have issued a Centenary Souvenir. It is as neat, colourful, pleasing and instructive as the garden it seeks to honour. Besides 5 finely printed colour plates the Souvenir is lavishly illustrated with nearly 100 photographs.

Dr. M. H. Mari Goda, the enthusiastic and energetic Superintendent of Government Gardens in Mysore and the Chairman of the Mysore Horticultural Society has, in a ten-page introductory article, narrated the history and the vicissitudes of Lalbagh from the time it was established by Hyder Ali round about 1760. This is the first authentic account of this great institution, the material for which was largely collected by Dr. Gowda when he was in Kew Gardens. He has vividly described the effective role that Lalbagh has played in making erstwhile Mysore the Garden State of India. As if to substantiate his claim, beautiful photographs of Lalbagh follow. These pictures take us from the main gate, now named the Cameron Gate after the famous Superintendent John Cameron to the Krumbiegel Gate leading to Basavangudi—through the equisite Japanese Garden, the majestic Glass House, the stately *Araucarias*, the quaint Bandstand, the lotus pond set in sylvan surroundings, the hoary Kempe Gowda Tower, the formal Statue Garden, the artistic Terrace Garden, the picturesque to piary and the lovely shimmering lake on the southern boundary.

Lalbagh is not merely a lovely spot. It is a treasure-house of plants from all climes and continents. It is a veritable *Pushpa Kashi*, the Mecca of flower lovers. In a comprehensive guide running to 97

pages under the title of the "Plant Wealth of Lalbagh", Sri. M. Dwarakanath Sharma has successfully attempted to take us round the different divisions of the garden and with appropriate plans and sketches introduces us to the rich variety of trees and shrubs which have found a sanctuary in this historic garden. Short descriptive notes have been given for each tree and shrub to enable us to recognise and appreciate the beauty and form of each subject. As if this was not enough, clear and faithful photographs have been put in to fix these pleasures in our mind and to help us to recall them in the privacy of our homes.

In a concluding article, Sri. A. H. Thirumala Rao, the Vice-Chairman, has traced the history of the Mysore Horticultural Society under whose auspices the Centenary was celebrated with great *eclat* in August 1957.

The 130 pages of this Souvenir is a sumptuous and satisfying fare to any student of botany or lover of horticulture. The Editor has spared no pains to make it instructive to the mind and delightful to the eye. Sri. Sharma is to be highly congratulated for bringing out this lovely publication in the record time of 3 months. It is a "must" for the library of all garden lovers.

M. L. N. IYENGAR.

PRINCIPLES OF AGRONOMY. By V. T. Subbiah Mudaliar. 1956. Royal 8 vo. Pp. xvi + 440. Price Rs. 17·50 or *sh.* 35.

A HANDBOOK OF ANIMAL HUSBANDRY AND DAIRYING. 1956. Royal 8vo. Pp. xii + 228. Price Rs. 8·75.

Both published by the Bangalore Printing and Publishing Co. Ltd. (Bangalore Press), Mysore Road, Bangalore-2.

To generations of readers of the *Madras Agricultural Journal* and of students of the Coimbatore Agricultural College, Sri. V. T. Subbiah Mudaliar's approach to and treatment of agricultural problems are very familiar. They have come to expect from him lucidity, sound agricultural knowledge based on decades of experience and originality in presenting his findings. These expectations have been amply fulfilled in the two books under review.

The author has covered the subjects of agronomy, cattle husbandry and dairying in an able and comprehensive manner, while no one will deny his ability and equipment for writing these books; *pandits* and experts may join issue with the reviewer in regard to the comprehensiveness of the books. They may find parts of the books patchy and

perfunctory particularly in respect of subjects in which they have specialised. But in the very first line of his preface, the author has modestly defined the scope of these two volumes as "being primarily intended for the use of students of agriculture and covering the syllabus prescribed by the universities therefor". Apart from the late A. K. Yegna Narayan Iyer's monumental books, there is hardly any volume on agronomy and animal husbandry with particular reference to conditions in South India. Even for other regions agricultural books are too few in number compared with the size of the sub-continent, its varied agricultural zones and the importance of this primary industry in her economy. Hence books on agriculture by Indian authors and based on Indian experience are very welcome. Sri. Mudaliar deserves our gratitude for writing these books.

The principles of agronomy have been delineated under four heads—soil, tillage, irrigation, manures and fertilisers and in 33 chapters. More than 125 pages have been devoted to soils, their formation and characteristics. The treatment of the subject is more functional than theoretical. Stress has been laid on the practical application of the principles. In some parts of the book, the author appears to have been carried away by enthusiasm for the subject. Six whole pages have been devoted to soil temperature and the same number of pages to an important subject like soil organic matter. The chapter on the "Clay Complex" is sketchy. It is surprising that such a practical-minded author has not referred to the empirical methods for determining the texture of soils in the field by feel, *viz.*, grittiness, silkiness and stickiness of sand, silt and clay fractions respectively. A soil specialist may have more points to pick out for criticism but as has already been mentioned, the book is not meant for the expert. All the same, a facile assumption that climate does not determine the types of soils formed in South India (page 82) need not have been allowed to creep in.

The author is most effective when dealing with tillage implements. Very useful information on indigenous implements of South India have been brought together almost for the first time in a text-book. There is a growing school of opinion that cultivations are overdone in India and that under dry farming conditions obtaining in this country great harm attends frequent cultural operations. Sri. Mudaliar steers clear of this subject by a droit omission of any reference to this controversy.

The chapter on irrigation is comprehensive but unfortunately the same cannot be said on the last part of the book, Manures and Fertilisers.

Two useful appendices, though unrelated to the subject directly, have been included on agricultural meteorology and field experimenta-

tion. They will be particularly useful to students who have neither the time nor the inclination to read the standard and more elaborate works on the subjects.

It is in the second book that the author is at his best. It is packed with his useful information garnered in a life-time. It is refreshingly practical and will prove useful not only to the student of agriculture but also to a progressive farmer. Although he calls it a handbook, it is in someways, an original contribution to the scanty Indian literature on cattle husbandry and dairying. Perforce it relates mainly to conditions in Madras and that part of Andhra Pradesh which was formerly part of Madras State. References to other regions in the south are few and sometimes erroneous as in considering that the Amrit Mahal Breed of Mysore is only a variant of the Hallikar type. Sri. Mudaliar is most useful both in this and the other book where he bases his information on his own experience which is both varied and unique on subjects which are outside one's experience one is apt to make mistakes and the author is no exception.

Ten chapters are devoted to Cattle Husbandry and another 10 for Dairying. To justify the title of the book, a small chapter has been written on other livestock, principally sheep.

The chapters on cattle husbandry are replete with useful titbits relating to the farmers practices such as feeding of *Acacia* pods to give a bloom to animal's coats (p. 14), feed of water hyacinth for buffaloes (p. 83), etc. The breeding principles are expertly and tersely discussed. Useful score cards for judging draught bullocks and Indian dairy cows are given. The section on "feeding" could have been more elaborate. The percentage composition of South Indian feeds and fodder is quite a useful table. Practical hints have been given on feeding and management of cattle.

These books are, in sum, not only useful to agricultural students but also to the body of English-knowing farmers.

The books are, as customary with the Bangalore Press, nicely printed and got up.

M. L. N. IYENGAR.

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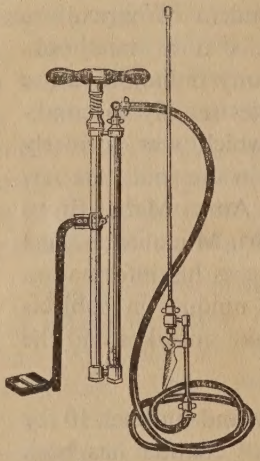
SPRAYERS & DUSTERS
FOR PLANTATIONS & FARMS



ASPEE
DOUBLE BARREL BUCKET SPRAYER
DOUBLE ACTION

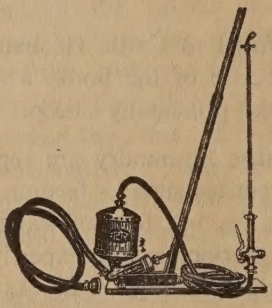
FOR SMALL-SCALE SPRAYING ON CITRUS TREES, FLOWER BEDS AND VEGETABLE PLOTS

CODE : AP-42

✠

MIST SPRAY NOZZLE

GOOSE NECK ATTACHMENT



GATOR
SPRAYER

SUITABLE FOR TWO SPRAY UNITS

DEVELOPS 200 ℔ PRESSURE

CODE : GR-11

SHANENE
HAND ROTARY DUSTER

FOR CONTROL OF BLISTER BLIGHT OF TEA & COFFEE

CODE : SRD-2

Manufacturers

AMERICAN SPRING & PRESSING WORKS
MALAD : : BOMBAY

Distributors

RANGASWAMI & CO., PLANT PROTECTIONISTS
93, NARASIMHARAJA ROAD, BANGALORE 2